

Intercomparison of Sampling
Techniques for Toxic Organic
Compounds in Indoor Air

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INTERCOMPARISON OF SAMPLING TECHNIQUES
FOR TOXIC ORGANIC COMPOUNDS IN
INDOOR AIR

by

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FOREWARD

Measurement and monitoring research efforts are designed to anticipate environmental problems; to support regulatory actions by developing an in-depth understanding of the nature of processes that affect health and the ecology; to provide innovative means of monitoring compliance with regulations; and to evaluate the effectiveness of health and environmental protection efforts through monitoring of long-term trends. The Environmental Monitoring Systems Laboratory, Research Triangle Park, NC, has responsibility for assessment of environmental monitoring technology and systems; implementation of agency-wide quality assurance programs for air pollution measurement systems; and supplying technical support to other groups in the Agency including the Office of Air and Radiation, the Office of Toxic Substances, and the Office of Solid Waste.

The determination of the identities and concentrations of toxic organic chemicals in indoor air is an area of increasing significance to EPA. The evaluation and intercomparison of sampling techniques which can provide information on indoor levels of toxic pollutants is an important step in developing the tools needed to address this issue. This report describes an intercomparison of several sampling techniques which are being evaluated for use in indoor air quality studies.

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ABSTRACT

People spend a major fraction of their time indoors, and there is concern over exposure to volatile organic compounds (VOC) present in indoor air. This study was initiated to compare several VOC sampling techniques in an indoor environment. The techniques which were compared include distributive air volume sampling, high and low rate passive sampling, and whole air collection in canisters. The study focused on ten target compounds:

chloroform	toluene
1,1,1 trichloroethane	tetrachloroethylene
benzene	styrene
bromodichloromethane	p-dichlorobenzene
trichloroethylene	hexachlorobutadiene

Altogether, ten separate 12-hour sampling experiments were conducted. Two experiments involved sampling the background air of the residence. For the other eight experiments, the indoor air was spiked with the target compounds. Three different spike levels were utilized to cover a range of target compound concentrations. The nominal spike concentrations were 3, 9, and 27 ng/l for each of the ten target compounds. All samples were analyzed by gas chromatography-mass spectrometry. Statistical analysis of the results indicates generally high correlation coefficients (greater than 0.90) between the methods. The most notable exception was benzene, which had lower correlation coefficients. In general, the distributed air volume sampling technique and the low rate passive technique measure concentrations less than or equal to the canister method.

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SECTION 1

INTRODUCTION

There has been an increasing need to measure volatile organic compounds in air. This need has been especially great for hazardous organic species in indoor air. A variety of approaches have been utilized for collection and analysis of hazardous organic pollutants in air. One of the most widely used sampling techniques is collection on Tenax solid adsorbent. An application of this approach is the TEAM study (1), in which 20 liter air samples were collected on Tenax cartridges. To minimize certain problems associated with Tenax sampling, Walling (2,3) and Walling and Bond (4) have devised a technique called distributed air volume sampling (DAV), in which four Tenax cartridges are collected simultaneously at four different flow rates.

Collection of whole air samples in passivated canisters is another technique which has been employed for volatile organic species sampling. While canister sampling has been utilized for a number of years (5,6), the hardware and procedures have recently been reexamined (7), and the technique has been validated for an increasingly long list of compounds (7,8).

Passive collection of volatile organic chemicals is a very attractive means of sampling, especially in performing human exposure studies. Considerable effort has been expended in recent years to develop and validate passive sampling devices (PSDs) for volatile organic species (9-12). Small stainless steel devices containing Tenax adsorbent behind a diffusion barrier have proven to be very successful for sampling a wide range of compounds, when used under appropriate conditions. Both high sampling rate and low sampling rate devices were employed in the present study.

Another technique which has recently been developed and validated for a number of hazardous organic air pollutants is automated cryofocussing gas chromatography. Recent reports have demonstrated the applicability of this approach for a number of specific compounds (13,14). In this

study, hourly sampling and analysis was carried out with an automated GC system.

All of the techniques noted above have been employed for ambient air sampling, and some have been used to sample indoor air. Several of these techniques were intercompared in the summer of 1984, using ambient urban air for sampling (8,15,16). The study reported here has compared these methods for the first time in an indoor environment, with the emphasis placed on a number of hazardous organic chemicals observed in indoor air.

OBJECTIVE

The objective of this research has been to intercompare volatile organic compound sampling techniques in indoor air. The intercomparison has been carried out under controlled conditions, with analytical uncertainties minimized as much as possible by employing the same GC-MS analysis procedure for all samples.

SECTION 2

SUMMARY AND CONCLUSIONS

The intercomparison of volatile organic compound sampling techniques was carried out in an unoccupied residence. The techniques which were compared include distributive air volume sampling, high and low rate passive sampling, and whole air collection in canisters. Samples were collected in duplicate for each technique except the canister procedures; each canister sample was analyzed twice, to provide an estimate of analytical precision for this sampling medium. All samples were analyzed within three days of collection by GC/MS. The study focussed on ten target compounds:

chloroform	benzene
1,1,1 trichloroethane	toluene
tetrachloroethene	styrene
bromo dichloromethane	p-dichlorobenzene
trichloroethylene	hexachlorobutadiene.

Altogether, 10 separate 12-hour sampling experiments were conducted. Two experiments involved sampling the background air of the residence. For the other eight experiments, the indoor air was spiked with the target compounds. Three different spike levels were utilized to cover a range of target compound concentrations. The nominal spike concentrations were 3, 9, and 27 ng/l for each of the 10 target compounds. Spiking was accomplished by vaporizing an initial charge of the 10-compound mixture into the furnace blower duct to achieve the approximate spike concentration. Throughout the remainder of the 12 hour period, the target compounds were continuously introduced into the duct from a gas cylinder at a rate calculated to make up for dilution caused by infiltration. The goal was to maintain the concentrations of the target compounds near the approximate spike level. Good mixing was required to ensure homogeneous concentrations throughout the residence. Continuous operation of the furnace blower and several oscillating fans located throughout the house was used to

provide thorough mixing, and also to provide the air velocity required for efficient operation of the passive devices.

For the distributive air volume technique, one blank was run for each sample (i.e. per set of four tubes). The blanks were transported to the field, but were not opened or handled prior to analysis. Duplicate samples were collected using a second distributive air volume collection system, and both the high and low rate passive samples were collected in duplicate. For three of the experiments, a separate set of distributive air volume samples was collected at rates specified by EPA/EMSL. These samples were returned to EPA/EMSL for analysis.

The automated real-time chromatographic system was used to assure proper levels of pollutants in the residence and for diagnostic purposes. The real-time system was not a part of the formal statistical inter-comparison of methods. The GC data provided greater temporal resolution than the integrating techniques, and these results can be used to determine whether the various target compounds are removed from indoor air at different rates due to adsorption or other scavenging processes. Temperature, relative humidity, and air exchange rate were monitored during each experiment.

All samples and blanks have been analyzed on the same GC-MS system to minimize the uncertainty in the analytical portion of the measurements so, that the comparison can focus on the sampling techniques.

The data from this study have been analyzed statistically by Northrop Services. The statistical methods and findings are included as an appendix to this report. The conclusions drawn from the statistical analysis are summarized below.

- (1) The distributed air volume (DAV) and canister methods were compared by regression techniques, with the following result:
 - (a) p-dichlorobenzene and hexachlorobutadiene had slope estimates less than one and the estimates were within two standard errors of one.
 - (b) Benzene, toluene and tetrachloroethylene had slope estimates greater than one and the estimates were within two standard errors of one.
 - (c) The five other compounds had slope estimates less than one and the estimates were more than two standard errors from one.

- (d) Styrene was the only one of the ten compounds with an intercept estimate (0.79 ng/l) more than two standard errors from zero.
 - (e) The more detailed statistical analysis indicated that for the DAV Tenax, the slopes for chloroform, 1,1,1-trichloroethane, and hexachlorobutadiene do not adequately represent the experiment and these results should be qualified.
- (2) Comparison of the low rate PSD and canister methods shows that all slope estimates were less than one and all intercept estimates were within two standard errors of zero. With the exception of benzene, the slope estimates for all compounds were not within two standard errors of one.
 - (3) Comparison of the high rate PSD and canister methods yielded the following results:
 - (a) Benzene had a slope estimate less than one and within two standard errors of one.
 - (b) Chloroform and bromodichloromethane had slope estimates less than one but these estimates were not within two standard errors of one.
 - (c) The seven remaining compounds had slope estimates greater than one and were not within two standard errors of one.
 - (d) Hexachlorobutadiene was the only compound with an intercept estimate more than two standard errors from zero.
 - (4) The correlation between Tenax means and canister means was generally large (>0.90) for all Tenax methods. The most notable exception was benzene, which had relatively small correlation coefficients for all Tenax methods.

Precision estimates were obtained for the three Tenax methods by pooling the variance of replicates over all experiments for PSD and DAV and over all nominal volumes for DAV. The precision estimate is taken as the square root of the pooled variance estimate. The compounds that showed precision estimates greater than 2.0 ng/l were benzene for the DAV and low rate PSD Tenax, toluene for all three Tenax methods, tetrachloroethylene for the DAV and high rate PSD Tenax, and hexachlorobutadiene for the low and high rate PSD. Precision estimates for the duplicate canister sample analyses were less than 1.2 ng/l for all compounds.

The DAV sampler and the high and low rate passive samplers had correlation coefficients greater than 0.90, which indicated that these devices tracked the canisters quite well. However the low rate PSD

concentrations were approximately 35 percent low and the high rate PSDs were approximately 15 percent high when compared to the canister VOC data. These considerations lead to the recommendation that additional laboratory and field studies are warranted for both the high and low rate PSDs to determine why the PSDs do not agree with the canisters as well as expected.

SECTION 3

EXPERIMENTAL

TEST RESIDENCE

The residence used for these experiments is located in the Upper Arlington suburb of Columbus, OH, approximately 10 km northwest of downtown. The test house was unoccupied during this study, and has been used for the past year for heating, ventilation, and air infiltration experiments. The house, which is shown in Figure 1, is a three bedroom, two bath ranch constructed in 1963. The exterior is aluminum siding over wood. The interior is furnished and carpeted. The walls and ceiling are primarily painted wallboard. The floor area is 1,400 square feet, and the house volume is 11,300 cubic feet. The house has been carefully sealed to minimize air infiltration rate, as part of other previous experiments at the house. The sealing efforts have virtually eliminated air exchange between the basement and the residential portion of the house.

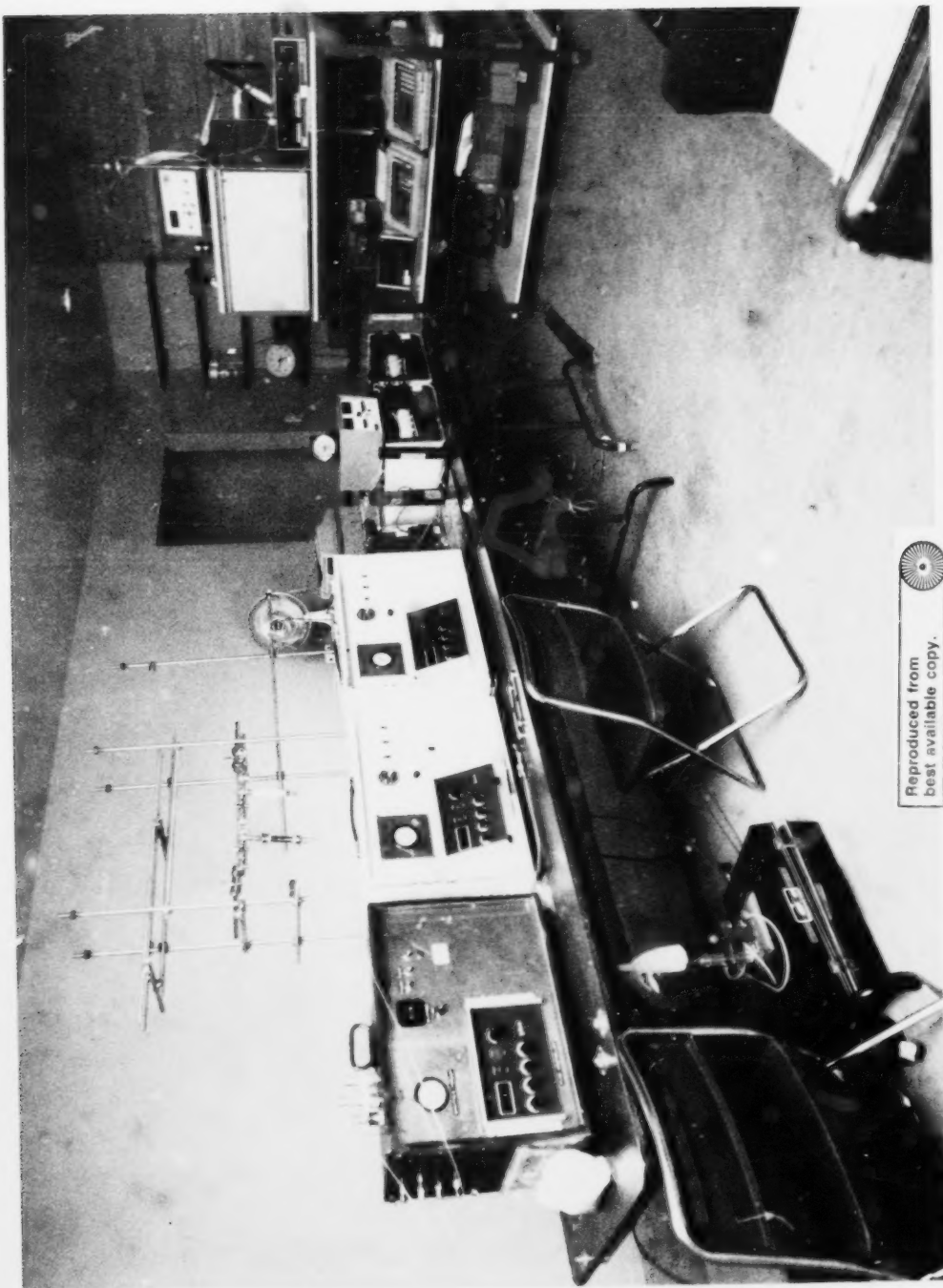
The test house has an attached garage which contained an inoperable vehicle during these experiments. It is likely that gasoline vapors from this vehicle's fuel system contributed to the background organic burden in the house during these experiments.

SAMPLING PROTOCOL

All sampling was conducted from the living room of the residence. An overview of the sampling system placement is provided in Figure 2. Samples for all the techniques were taken from a common area in the living room. To assure good mixing throughout the house, the furnace blower was operated continuously, and each room contained one or more oscillating fans. The furnace itself was not operated during the study, and the furnace filter was removed and the duct sealed to eliminate the possibility of organic compound removal by the filter or the material collected thereon. Prior to the start of the organic sampling experiments, a test of the mixing rate was carried out by injecting NO into the cool air return



Figure 1. Exterior view of test residence.



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Figure 2. Sampling systems in living room of residence.

duct and monitoring of the NO concentration in the living room. The NO reached a stable concentration within three minutes, indicating rapid mixing throughout the residence.

Air velocity measurements were made in all rooms of the house with the blower and oscillating fans operating. The velocities ranged from 15 to 70 ft-min⁻¹, with the lowest velocities measured in the bedrooms and the highest in the living room. The air velocity in the vicinity of the sampling apparatus in the living room was maintained between 25 and 70 ft-min⁻¹ through the use of two oscillating fans.

For some experiments, it was necessary to increase the relative humidity in order to test the sampling methods under high humidity conditions. For these experiments, the house was opened to outside air for several hours prior to the start of the experiment. One hour before the start of sampling, the house was sealed, and the humidity level was further increased by boiling water on the electric kitchen range.

The real-time automated GC collected and analyzed a sample each hour; all other techniques collected integrated samples over a 12 hour period. All experiments were carried out in the months June-September, 1985.

SPIKING PROCEDURE

As indicated earlier, ten experiments were carried out at the study site. Experiments 1 and 9 focused on sampling the background air of the residence, while the remaining experiments involved spiking the home with a set of target compounds. Three different spike levels were utilized during the eight spiking experiments (see Table 1). The nominal spiked concentrations were 3, 9, and 27 ng/l for each of the ten target compounds.

TABLE 1. EXPERIMENTS SPIKED WITH TARGET COMPOUNDS

Experiment No.	Spike Level, ng/l
1	background
2	3
3	3
4	9
5	9
6	27
7	27
9	background
10	3
11	9

To carry out the spiking experiments, a liquid mixture was initially made up which contained equal amounts (on a mass basis) of the ten target compounds. An aliquot of the mixture was then injected into an evacuated cylinder. Following equilibration of the mixture, the cylinder was pressurized to 1000 psig. Component concentrations in the cylinder are shown in Table 2. House spiking was initiated by placing a measured amount of the liquid cocktail onto a watch glass, placing it in front of the cold air return duct and slowly vaporizing the mix with a heat gun (Figure 3). Following this initial injection, the target compounds were continually introduced into the duct from the gas cylinder at a rate calculated to make up for house dilution caused by infiltration. The overall objective was to maintain the concentrations of the target compounds near the initial spiking level. Continuous operation of the furnace blower and several oscillating fans located throughout the house ensured rapid mixing.



Figure 3. Injection of test compound mixture into test residue duct.

TABLE 2. COMPOSITION OF HOUSE SPIKING CYLINDER*

Compound	Concentration, ppm
chloroform	36
1,1,1-trichloroethane	33
tetrachloroethene	26
bromodichloromethane	27
trichloroethene	33
benzene	56
toluene	47
styrene	30
p-dichlorobenzene	30
hexachlorobutadiene	17

* On a mass basis each component concentration is ~180 µg/l.

Based upon a house volume of 3.11×10^5 l (11,000 ft³) an initial charge of 15 µl of the liquid cocktail provided nominal concentrations of ~1 ppb. Using an average air exchange rate of 0.2 hr⁻¹, a gas flow rate of ~30 cc/min from the cylinder was needed to maintain a 1 ppb concentration level over the 12 hour run. Values for the other two spiking levels were scaled proportionally.

SAMPLING METHODOLOGY FOR TARGET ORGANIC COMPOUNDS

Distributed Air Volume Sampling

Sampling with Tenax adsorbent tubes was accomplished with the system shown in Figure 4. For experiments 1 through 4, the mass flow controllers were adjusted so that nominal air volumes of 5, 10, 15 and 20 liters were collected over the 12-hour sampling period. For experiments 5 through 11, nominal sample volumes of 5, 10, 20 and 40 liters were collected. Actual volumetric flow rates were measured before and after each experiment. Flows were determined as follows. All inlet lines were sealed and a bubble flow meter was attached to the pump exhaust. A leak-free system was indicated by zero readings on the mass flow controllers and no flow movement through the bubble meter. Each tube position was then sequentially

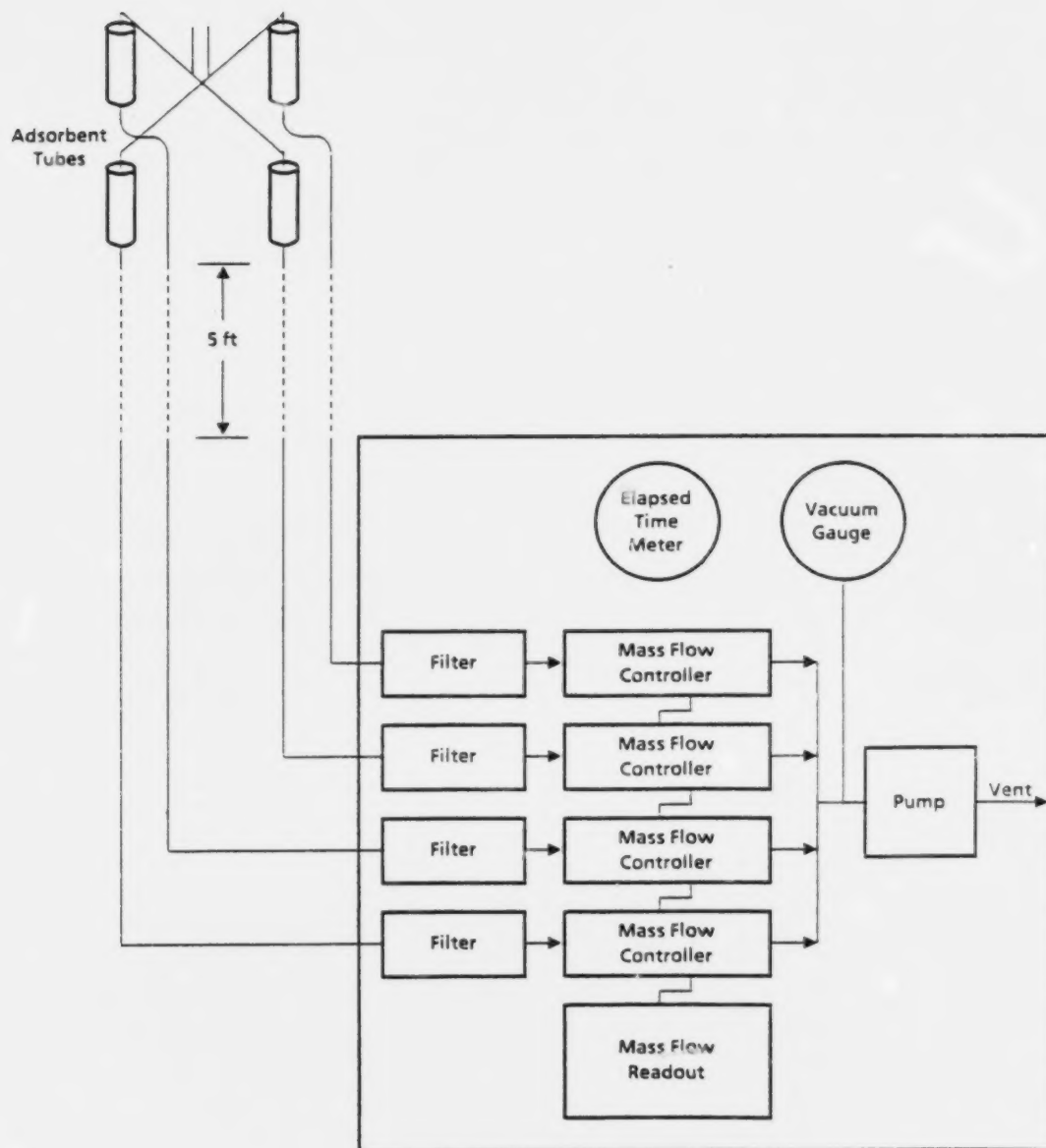


Figure 4. Diagram of distributive air volume sampler.

opened and closed to permit individual flow and zero measurements. Volume flow was corrected to 25°C and a pressure of 29.92 in. of Hg. using the following equation:

$$\text{Volume flow (cc/min, NTP)} = \frac{\text{Measured Volume (cc)}}{\text{Time (min)}} \times \frac{P - P_v}{29.92} \times \frac{298}{273 + t}$$

P = atmospheric pressure (in. of Hg.)

P_v = vapor pressure of water (in. of Hg.)

t = temperature of gas (°C) .

Duplicate sets of Tenax adsorbent tubes were collected during all 10 experiments. These tubes consisted of packed glass cartridges as used with the Volatile Organic Sampling Train (VOST) System developed by EPA for stack sampling. EPA/EMSL adsorbent tubes (stainless steel design) were also employed in a third sampler during experiments 4 through 6. The cartridge geometries for these two designs are shown in Figure 5 and the tubes are pictured in Figure 6. Both tube styles contain approximately the same amount of adsorbent material (-1.7 gm).

Tenax GC for the VOST-type cartridges was purchased from Alltech Associates. Prior to packing the Tenax into the sampling cartridges, the bulk material was extracted in a Soxhlet apparatus with methanol followed by pentane, each for 24 hours (approximately 10 cycles/hour), and dried in a vacuum oven at room temperature using a water aspirator. The clean material was then transferred to the individual glass cartridges. Within 48 hours before use, the sampling cartridges were further cleaned by heating (240°C) under a helium purge (50 ml/minute). A Nutech adsorbent clean-up apparatus (Model 322) facilitated this process. Fourteen cartridges could be prepared simultaneously with the unit. A minimum clean-up time of four hours was utilized in this study. When not being used for sampling or analysis, all Tenax cartridges were stored at room temperature in one-gallon metal cans containing a layer of charcoal.

All EPA/EMSL adsorbent tubes were stored in Teflon screw-cap glass culture tubes and placed in sealed metal cans containing activated charcoal. When not in use, the adsorbent tubes and storage cans were housed in a refrigerator. All EPA samples were shipped to and from Columbus by air express. Special nylon gloves were utilized during all sample handling

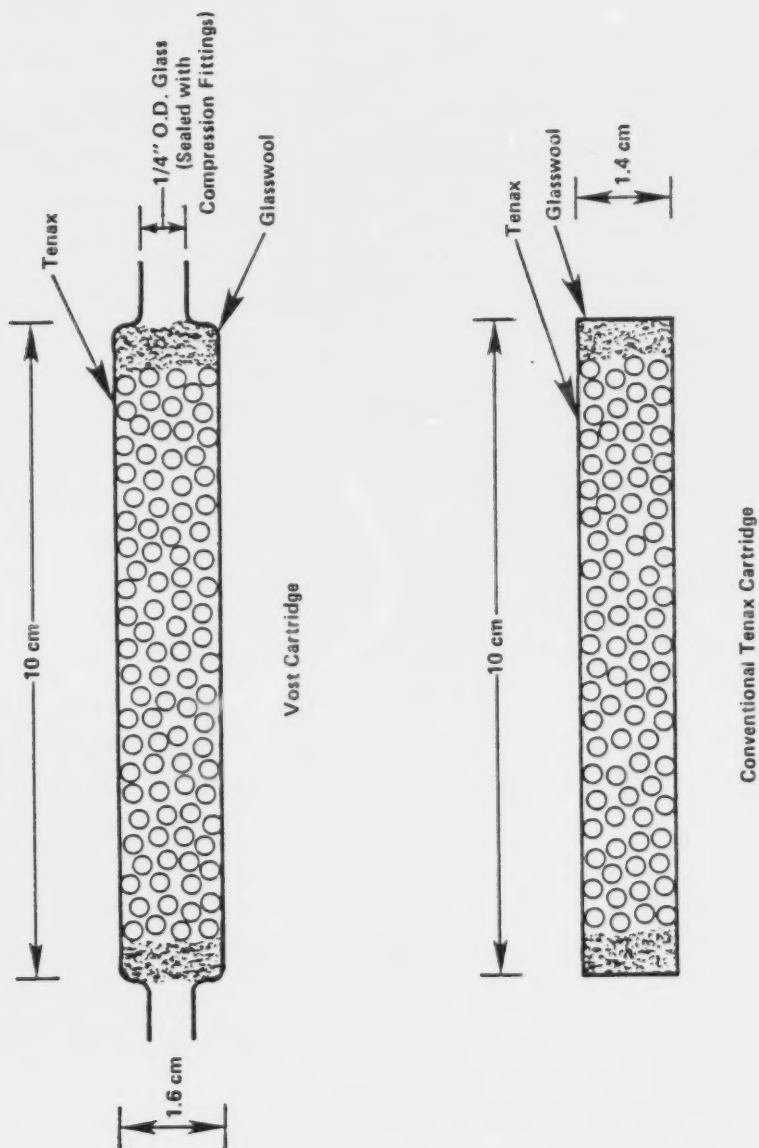


Figure 5. Diagram of conventional and Vost style Tenax sampling tubes.

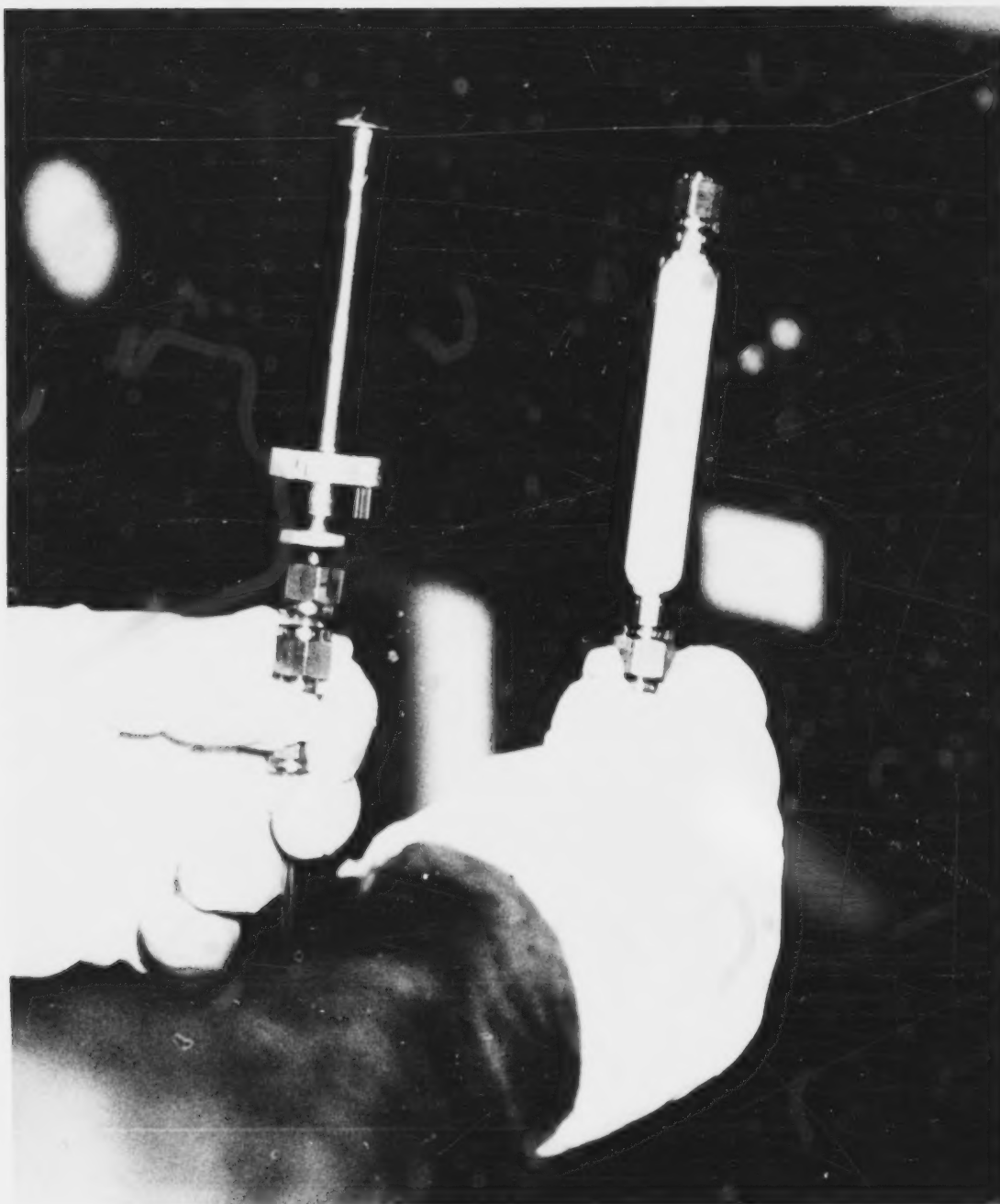


Figure 6. Tenax traps used by EPA (left) and Battelle for indoor sampling study.

procedures, because the outer surface of the EPA Tenax tubes is desorbed into the analytical instrumentation.

A sample blank was carried along with each set of four Tenax cartridges. The blank cartridge was not removed from its storage container but simply accompanied the four adsorbent tubes to the test site and then back to the laboratory for analysis.

Canister Sampling

Six-liter stainless steel canisters (Demaray Scientific Instrument, Ltd.) were used for collecting integrated whole air samples. Figure 7 shows a diagram of the canister filling apparatus. A stainless steel pump (Metal Bellows Corp., Model-158) directs flow to the sample canister. The sampling rate is controlled with a mass flow controller (Tylan, FC-260). A stainless steel tube restrictor (0.03 inch i.d. by 6 inch length) was positioned upstream of the mass flow controller to prevent pump oscillations from affecting the mass flow. The sample flow was set so that a final canister pressure of -10 psig was achieved (i.e. -10 cc/min for a 12-hr sample period).

In preparation for sampling, the canister was sequentially filled (15 psig) and evacuated (25 in. of Hg.) five times using zero air (Aadco, Inc.) as the flushing gas. After the fifth evacuation, the canister was sealed, transferred to a higher vacuum system and pumped down to 0.1 torr. A liquid nitrogen trap was utilized in this system to prevent contamination from the pump oil. An oven (100°C) was also used to bake out the canisters during evacuation. Following the final evacuation step, the canister was transferred to the field site and connected to the collection apparatus.

Real-Time Automated Gas Chromatographic Sampling and Analysis

The automated cryogenic GC system used for real-time sampling and analysis at the field site was composed of two instruments (see Figure 8). Sample collection was accomplished with a modified Nutech Model 320-01 cryogenic unit. The Nutech instrument contained two subsystems. An electronics console was employed for setting and controlling various temperature zones, while the sample handling unit contained the six-port

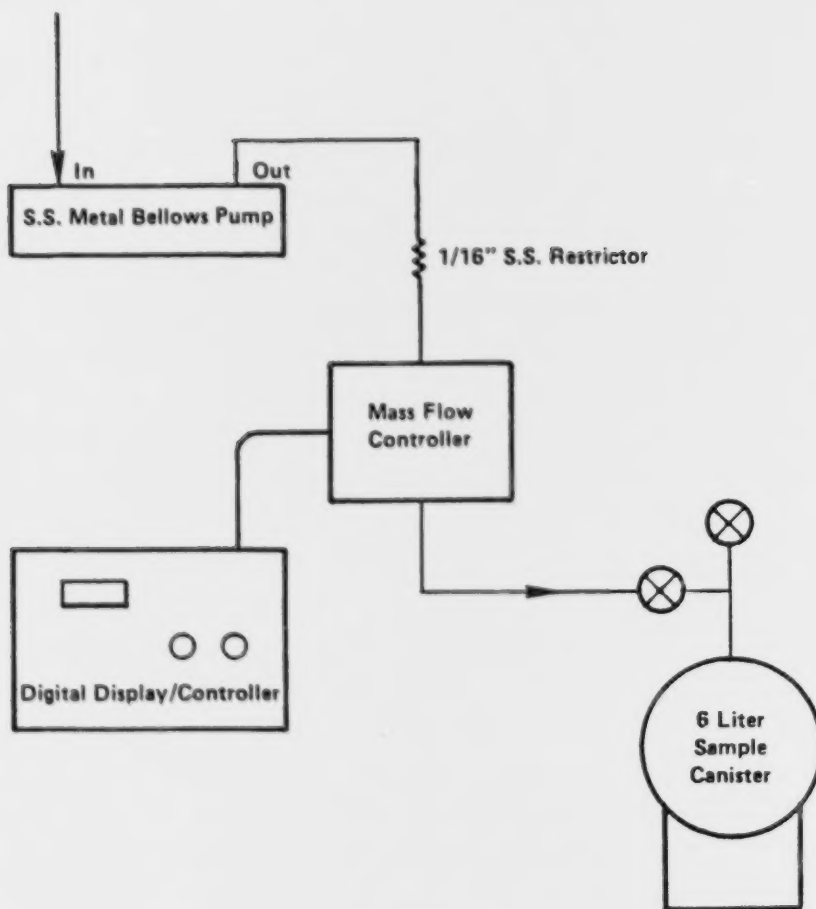


Figure 7. Schematic diagram of canister sampling apparatus.

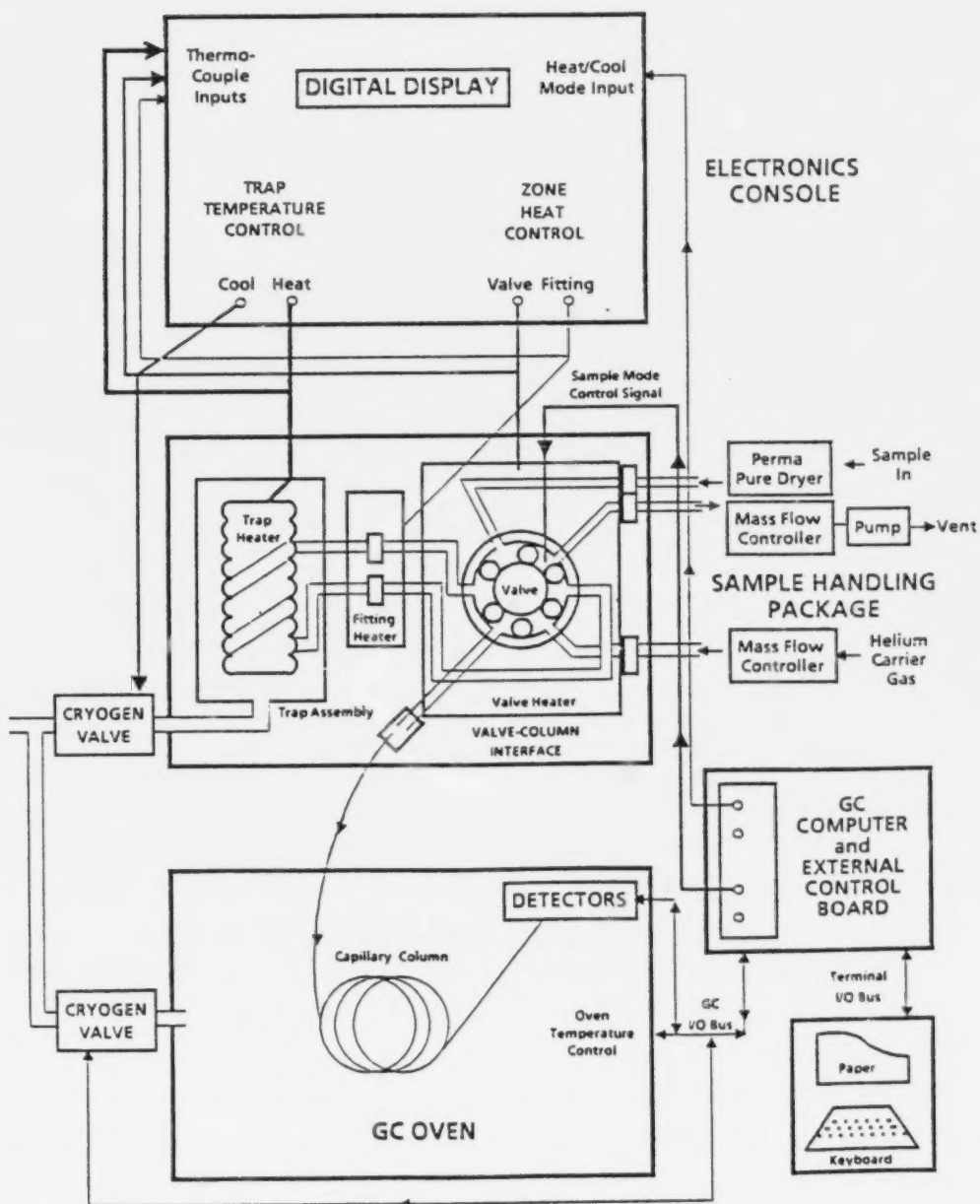


Figure 8. Block diagram of cryogenic gas chromatographic system.

valve and cryogenic trapping components. Three temperature zones were controlled by the console, including the valve, trap, and transfer lines. The valve and transfer lines were maintained at 120°C. During sample collection the trap temperature was regulated by the electronics console, which controlled the release of liquid nitrogen via a solenoid valve. During the current study the temperature setpoint of the trap during sample collection was -160°C $\pm$ 5°C. A cylindrically coiled 250 watt heater was used to heat the trap during the sample desorption cycle. The trap was wrapped around the heater to promote heat transfer during the desorption cycle (-160°C to 120°C in 60 sec). Rapid heating of the trap provided efficient transfer of the sample components onto the gas chromatographic column. The sample trap was constructed of 20 cm by 0.2 cm i.d. stainless steel tubing packed with silanized glass beads (60/80 mesh). A Carle six-port air-actuated valve (Hach Company) was used to facilitate sample collection and injection.

Sample analysis was achieved with a Hewlett Packard Model 5880A (Level 4) gas chromatograph equipped with flame ionization and electron capture detectors. A 50 m by 0.32 mm i.d., OV-1 fused silica column (Hewlett Packard) was used to resolve the target compounds. The column flow was maintained at 4 ml/min with a mass flow controller (Tylan MC-260). Zero grade helium (Matheson) served as the carrier gas, and zero grade nitrogen (Matheson) was used as the make-up gas to provide proper electron capture operation. Optimum analytical results were achieved by temperature programming the gas chromatographic column from -50°C to 150°C at 8°C/min. The column exit flow was split (50/50) using a low dead-volume union with a two-hole ferrule. One portion of the flow was directed to the flame ionization detector; the remaining flow passed through the electron capture detector.

A Perma Pure dryer (Model MD-125-48F) with a tubular hygroscopic ion-exchange membrane (Nafion) was used to remove water vapor selectively from mixed gas streams. The dryer was purchased in a shell and tube configuration. The tube size was 30 cm by 0.1 cm i.d. and was imbedded within a shell of Teflon tubing of 0.25 cm i.d. Sample flow through the tube was maintained at 10 ml/min with a mass flow controller (Tylan MC-260). A counter-current flow of dry zero air (200 ml/min) was used to purge the shell.

A gas-phase dynamic dilution system (Columbia Scientific Industries) was employed at the field site to generate ppb mixtures of the target compounds. Ultra-zero air (Matheson) was the diluent gas. Internal mass flow controllers provided accurate gas flows, which were verified with a soap-film bubble meter. (The same gas cylinder was utilized for calibration of the field and laboratory GC instruments.)

The software for the automated GC system permitted the operator to specify the start time (24 hour clock), the sampling frequency and the sample volume to be collected. For the current study the GC system was programmed to collect a 15-minute integrated sample every hour. Sample analysis immediately followed each collection period.

The automated GC was usually activated several hours before the start of the official sampling period. This procedure provided background concentrations before spiking, and also permitted an almost immediate check on compound spiking levels.

Passive Device Sampling Procedure

Two types of passive sampling devices (PSDs) were utilized in this study. Both are stainless steel cylinders filled with 0.4 g Tenax GC. The device shown schematically in Figure 9 was designed to have a relatively high sampling rate for organic compounds. This device, which has been characterized by Lewis et al. (10), employs sets of 200-mesh stainless steel screens as the diffusion barrier.

The second type of device is similar to that shown in Figure 9, except that the 200-mesh screen is replaced by a stainless steel plate with a single 0.5 mm hole in the center. A picture of this device is shown in Figure 10. This device was designed to have a reduced sampling rate. This low rate device has been described and evaluated for VOC sampling by Coutant et al. (12).

The sampling rates for PSDs employing reversible adsorption are dependent on the specific design of the device as well as the retention volume of each organic compound with respect to Tenax. The theory behind PSD sampling rate has been presented by Coutant et al. (11). Based on the design specifications of these devices and the 12-hour exposure time used in this study, the effective sample volumes for each target compound are shown in Table 3. A time weighted average sampling rate was used to

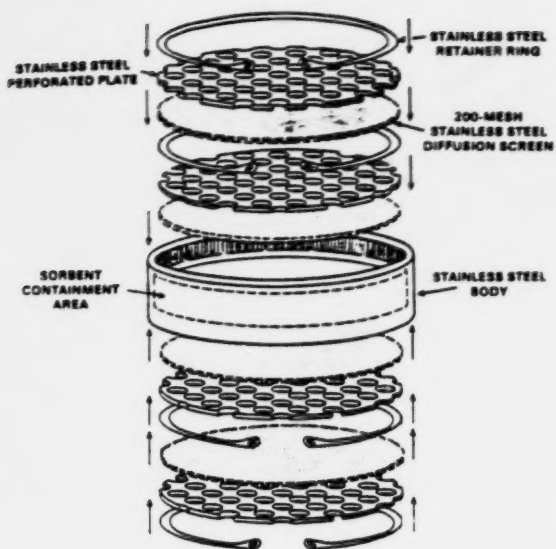


Figure 9. Thermally desorbable passive sampling device.



Figure 10. Low rate passive sampling device.

compute the volumes for the high rate PSD, because the rate decreases with time for some compounds over the 12-hour sampling period. It should be noted that the sampling rate, and therefore the sampled volume, for the low rate PSDs has an uncertainty of about ± 25 percent.(12)

Table 3. 12-HOUR SAMPLE VOLUMES FOR HIGH RATE AND LOW RATE PASSIVE SAMPLING DEVICES

Target Compound	High Rate PSD Volume (l)	Low Rate PSD Volume (l)
chloroform	8.28	1.80
1,1,1-trichloroethane	5.19	1.53
tetrachloroethylene	36.2	1.86
bromodichloromethane	28	1.70
trichloroethylene	16.6	1.89
benzene	17.9	2.01
toluene	40.3	1.92
styrene	46	1.81
p-dichlorobenzene	41	1.53
hexachlorobutadiene	31.4	1.25

Before sampling, the PSDs were cleaned by baking at 200°C for at least two hour in an oven designed to hold 10 PSDs. During bakeout, the PSDs were exposed to a flow of 100 ml/min of hydrocarbon-free N₂. Following cleanup, the PSDs were stored in a stainless steel cylinder which was purged with hydrocarbon-free N₂ and pressurized through a quick-connect fitting. The PSDs were transported to and from the residence in this device, and the blank PSDs were kept in the cylinder at the residence during sampling.

At the start of each sampling period, the PSDs were removed from the transfer cylinder and positioned approximately 8 in. apart on a metal rack in the living room of the residence. A picture of the PSDs deployed for sampling is shown in Figure 11. Three high rate and three low rate PSDs were employed for each experiment. Two devices of each type were analyzed; the third was collected as a backup. One of each PSD type was

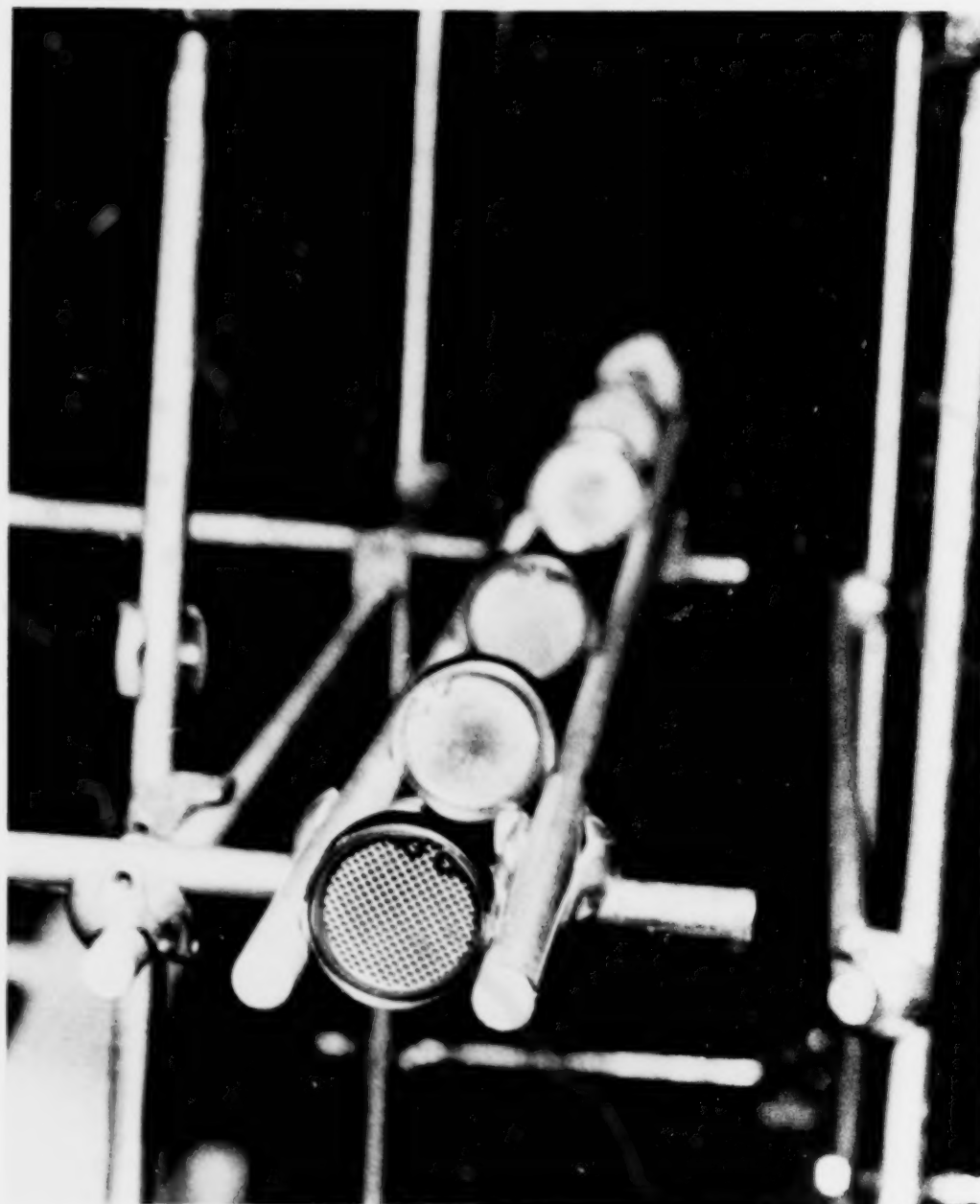


Figure 11. Passive sampling devices as deployed for sampling in test residence.

transported to the residence for use as a blank. These PSDs were not removed from the transfer cylinder.

Efficient operation of the PSDs requires movement of air around the device to replenish the boundary layer which is depleted by sampling. Following the recommendation of Lewis et al. (10), we operated the furnace blower and three oscillating fans in the living room during each experiment. This provided linear velocities of 25-35 ft-min⁻¹ at the location of the PSDs.

ANCILLARY MEASUREMENTS

Additional measurements which were made to complement the organic species sampling intercomparison included temperature, relative humidity, NO/NO_x, and air infiltration rate. These measurements were made in the living room simultaneously with the organic species sampling. The arrangement of the instruments is shown in Figure 12. Temperature and relative humidity were monitored with an EG&G Model 911 unit. The concentrations of NO and NO_x were monitored with a CSI Model 2200 portable chemiluminescence instrument. Readout from both of these instruments was recorded on two Weather/Measure dual channel recorders. NO/NO_x data are missing for some experiments due to a malfunction with the chemiluminescence instrument.

Air infiltration rate was measured by the decay method, using SF₆ as the inert tracer. Prior to the start of the experiments, 1 cc of SF₆ was injected by gas tight syringe into the cool air return duct of the furnace/blower system. The concentration of SF₆ was measured every 30 minutes throughout each 12 hour experiment with a Hewlett Packard Model 5790 electron capture gas chromatograph with a 1 cc sampling loop and automated gas sampling valve. A sequential molecular sieve 5A and Porapak Q column was operated at 55°C with N₂ carrier gas. Detector temperature was 270°C. The chromatographic signal was plotted and integrated by a Hewlett Packard 3390 integrator. Air infiltration rate for each 12 hour experiment was determined from the slope of a semilog plot of SF₆ concentration versus time.

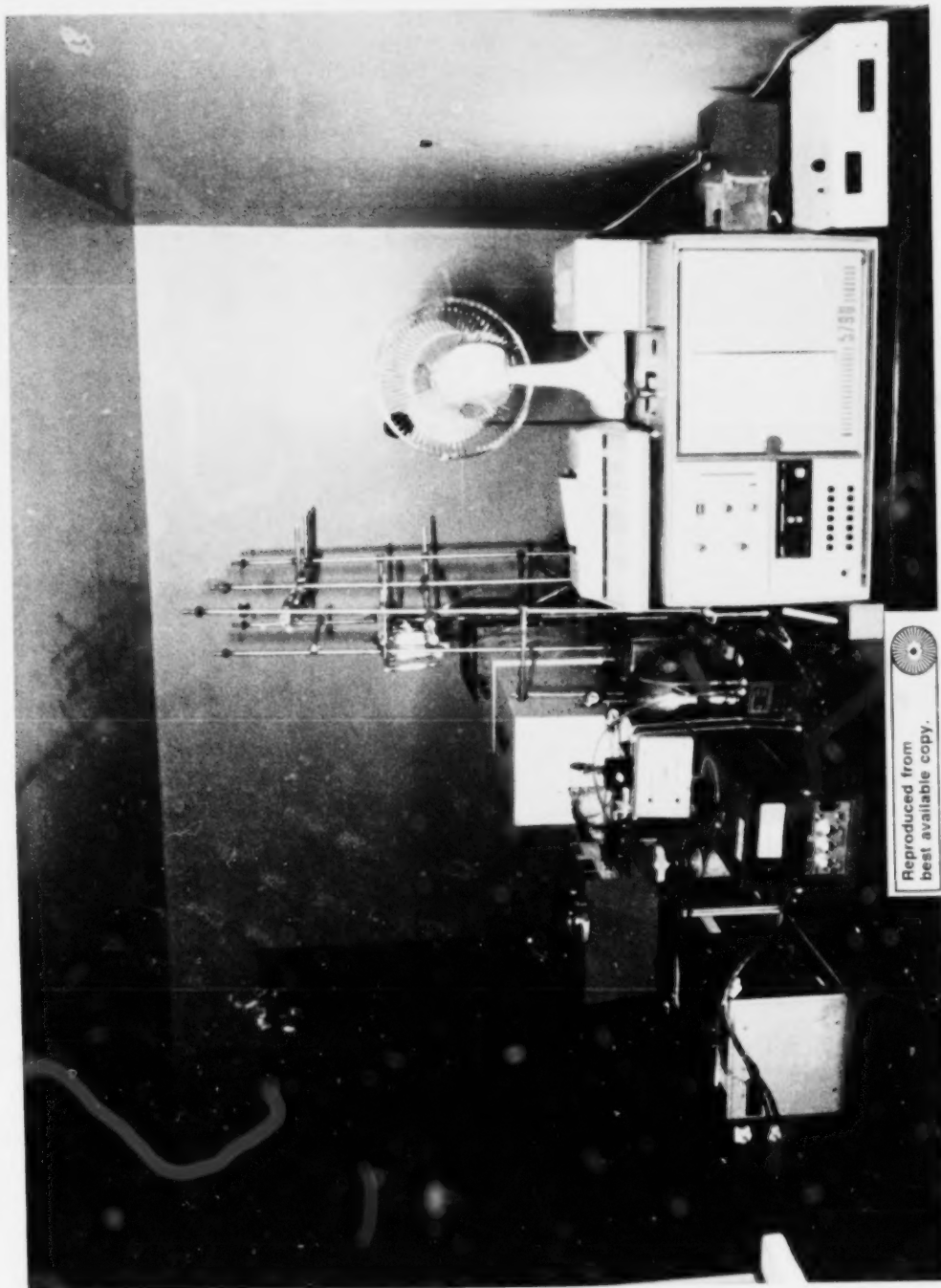


Figure 12. Chemiluminescence NO/NO_x monitor and SF₆ gas chromatograph in living room of test residence.

ANALYSIS METHODOLOGY FOR TARGET ORGANIC COMPOUNDS

GC/MS Description

The instrumentation used in this study consisted of an Extranuclear (now Extrel) simulscan quadrupole mass spectrometer interfaced to a Hewlett Packard 5710A gas chromatograph. Data acquisition and reduction was performed using an INCOS 2300 data system. In order to accommodate calibration, canisters, PSD and DAV sampling devices, the multipurpose inlet system illustrated in Figure 13 was used in place of the conventional split/splitless injector of the GC. The heart of this inlet system consists of two 6-port Carle valves in series to route sample or calibration standard to the GC column. Various configurations of the valves were used depending on the sampling device and are described in later sections of this report. The 6-port valves and a 5 cc calibration loop were maintained in an enclosure at 100°C. A single standards cylinder was used for all external standardization analyses. The first 6-port valve provided selection between sample and calibration standard while the second 6-port valve controlled the flow through a cryogenic trap packed with glass beads. The glass bead trap provided a common cryofocussing stage for all analyses including standards.

The cryogenic trap illustrated in Figure 14 consists of a 20 cm loop of 1/8" OD stainless steel tubing packed with 60-80 mesh silanized glass beads. The trap was maintained at 87°K with liquid Argon during the cryofocussing step. The cryotrap was then heated to 160°C while back flushing with 3 ml/min. of helium for a period of 7 minutes. The cryotrap eluent was routed to a Hewlett Packard 50 m crosslinked SE 30 wide bore, thick film, fused silica capillary column using a 6-port valve maintained at 100°C. The initial column temperature was -20°C.

The mass of material injected into the GC varied significantly among the techniques because the sample volumes were quite different. For example, canister analysis employed a 1 liter sample, while the highest flow rate DAV trap used a 40 l sample. This wide range of sample volumes, combined with the range of concentrations tested necessitated use of a dual calibration system. A 5 cc calibration loop was used to provide a known low volume of the calibration standard for use with the canisters and low rate PSDs. Larger volumes of the standards cylinder were sampled

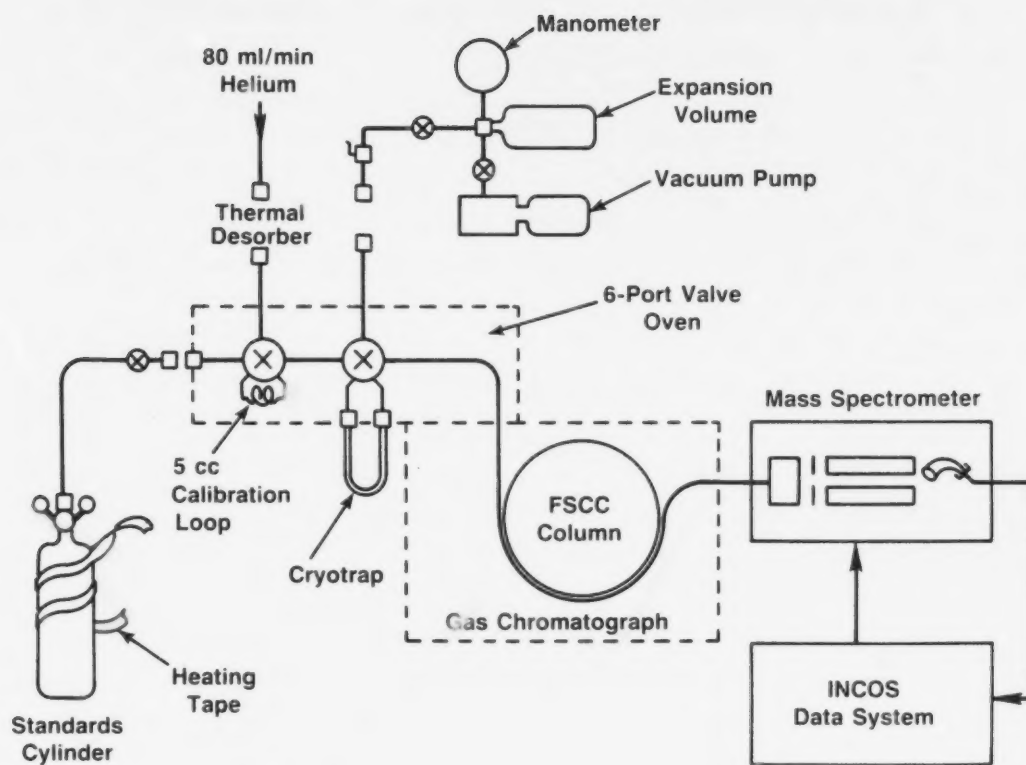


Figure 13. GC/MS system with multipurpose inlet.

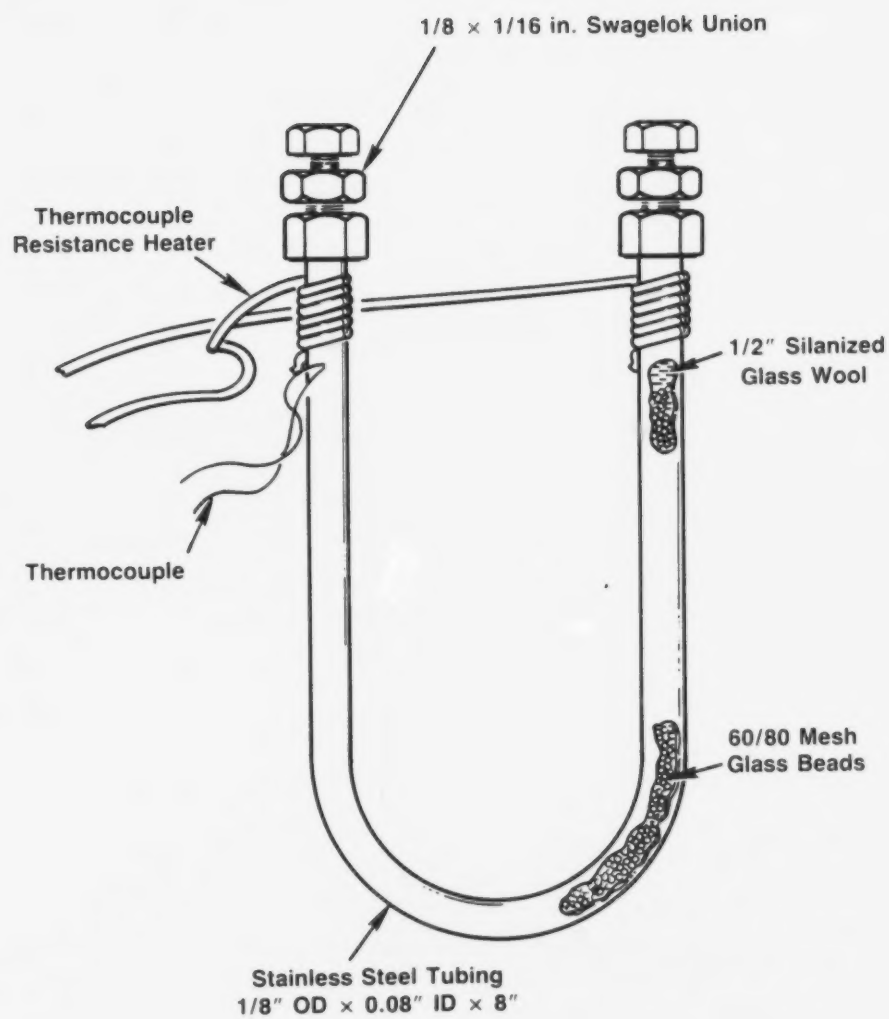


Figure 14. Diagram of the cryogenic trap.

using a calibrated expansion volume apparatus shown in the upper right portion of Figure 13. These larger volumes were used to provide a calibration reference for the DAV samples and high rate PSDs. The expansion volume apparatus was also used to analyze a known volume of air from the canisters. A 1 meter Nafion sampling line (not shown) was routed from the canister to the multipurpose GC inlet system at the same point as that used for the PSD desorber and the DAV cartridge. The canister was maintained was at 100°C. When the expansion volume apparatus was not being used, it was disconnected to provide a vent to the atmosphere during cryotrapping of the DAV and PSD thermal desorption eluents.

A common set of GC/MS conditions was used for analyses. Following cryotrap desorption, the column was temperature programmed at 80/min to 200°C. GC/MS acquisition was initiated after a 6 minute delay. Electron impact ionization of 70 eV was used with the instrument scanning from m/z 46-270 at a 0.50 second cycle time.

Data reduction was performed automatically using in-house developed software. This involved retention driven reverse search for the target analytes followed by integration of characteristic extracted ion current profiles. Quantification was performed by comparison to the chromatographic peak areas of a known standard. Calibrations and performance checks were performed by cryotrap sampling a known volume of gas from an aluminum compressed gas cylinder containing nominally 1.0 ppm in nitrogen of each of the target analytes. The concentration of benzene in the calibration cylinder was found to be within 7 percent of the calculated value based on direct comparison with an NBS primary standard cylinder.

Calibration

An aluminum standards cylinder was prepared containing known concentrations of each analyte in nitrogen. The composition of the standards cylinder is summarized in Table 4. Perfluorobenzene and perfluorotoluene were included as surrogates rather than internal standards. This cylinder served as a single source of external standards for canister, DAV and PSD analyses throughout the study. Calibration consisted on introducing a known volume (10 cc or 250 cc at NTP) of the standards cylinder directly onto the cryotrap. The 10 cc calibration was applied to the low volume sampling devices (canister and low rate PSD) while the 250 cc calibration

TABLE 4. COMPOSITION OF STANDARDS CYLINDER
(ppm at normal temperature and pressure)

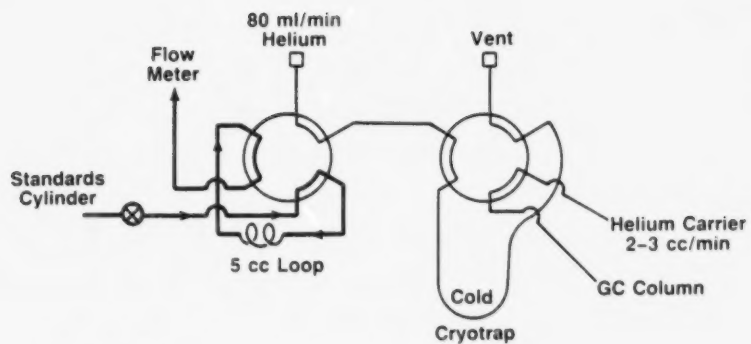
Compound	Concentration	QUAN MASS	Typical* Response
Perfluorobenzene	1.00	117	0.225
Chloroform	1.50	83	0.387
1,1,1-Trichloroethane	1.00	97	0.301
Perfluorotoluene	1.00	217	0.154
Benzene	1.00	78	1.00
Bromochloroform	1.00	83	0.297
Trichloroethylene	1.00	130	0.251
Toluene	1.00	91	1.10
Tetrachloroethylene	1.00	166	0.136
Styrene	1.00	104	0.853
1,4-Dichlorobenzene	1.00	146	0.394
Hexachlorobutadiene	2.00	225	0.093

* Concentration corrected, relative to benzene. Absolute response was used for quantification.

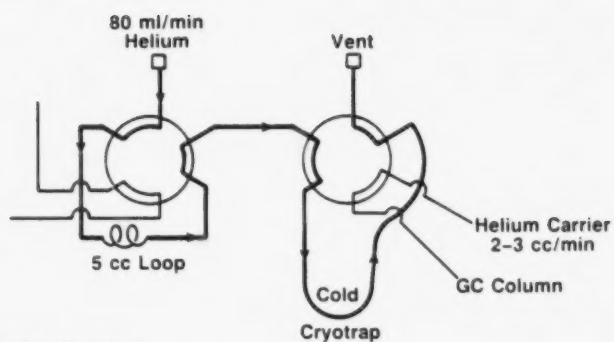
was applied to the higher volume sampling devices (DAV tubes and high rate PSD). Actual sample analyses were grouped in this fashion. The analysis sequence typically consisted of response calibration with 10 cc of standard followed by analysis of canisters and low rate PSDs. The system was recalibrated with 250 cc of standard followed by analysis of the DAV and high rate PSDs. The mass spectrometer multiplier gain was adjusted to provide equivalent instrument response for the 10 cc and 250 cc standards. The electron multiplier was configured with a -3.0 Kv conversion dynode in order to prevent mass discrimination that may result from changing multiplier voltages. The approach of separately calibrating the high and low volume sampling devices was chosen in order to retain as much dynamic range as possible for each type of sampling device.

The low level calibration was accomplished by twice filling a calibrated stainless steel loop with the gas standard and flushing the contents onto the cryotrap. This sequence is partially illustrated in Figure 15. The standards cylinder, stainless steel regulator and transfer lines to the 6-port valve assembly were wrapped with heating tape and maintained at 60°C. The 6-port valves and the 5 cc loop were maintained at 100°C. The 5 cc loop consisted of a coil of 1/8" OD x 0.08" ID stainless steel tubing of approximately 60" in length. The actual volume of the loop and fittings was determined to be 5.10 cc. The loop and valves were maintained at 100°C in order to ensure equivalent transfer efficiencies for all components of the standard cylinder and sampling devices. At that temperature, the 5.10 cc loop contained the equivalent of 4.07 cc of standard at normal temperature (25°C). Two aliquots of the standard delivered to the cryotrap corresponds to an equivalent of 8.14 cc at room temperature of the cylinder standard.

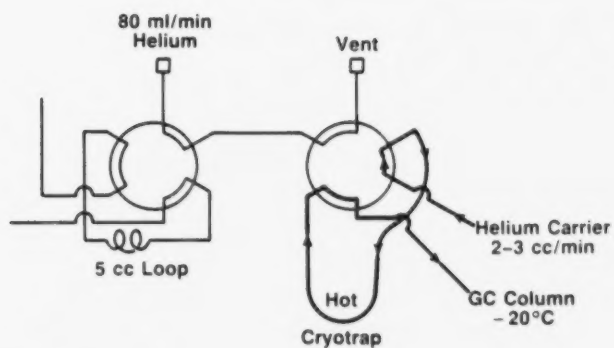
The loop was filled for 1 minute at a flow rate of 100 ml/min. Standards flow was stopped for a period of 15 seconds prior to transfer to the cryotrap in order to allow temperature and pressure equilibration in the loop. The loop was then flushed onto the cold cryotrap with helium at 80 ml/min for one minute, after which the valve was returned to the loop fill position. This sequence was repeated to transfer a second aliquot. Following this, the second 6-port valve was rotated to backflush the cryotrap with helium carrier gas at a nominal 3 ml/min. The liquid argon



A. Loop Fill



B. Transfer to Cryotrap



C. Injection on Column

Figure 15. Sampling sequence for low level calibration standard.

cryogen was removed and the cryotrap heated to 160°C for 7 minutes in a manner identical to that used for all sample collection devices.

For the high volume calibration, the 80 ml/min helium purge was replaced with the heated transfer line from the standards cylinder. The vent shown on the second 6-port valve in Figure 15 was attached to a calibrated expansion volume previously evacuated to approximately 150 torr. This configuration is illustrated in Figure 16. The swagelok connections were leak checked by closing the valve on the standards cylinder and opening the needle and toggle valves on the expansion volume. This needle valve served to control the flow into the expansion volume at approximately 80 ml/min. The standards cylinder valve was opened momentarily while the cryotrap was maintained at 160°C in order to purge the valve plumbing with 125 cc of cylinder standard and remove any residual organics from the cryotrap. The flow was stopped with the toggle valve and the trap cooled by immersion in liquid argon. After approximately one minute for trap temperature equilibration, the standards flow was resumed at 80 cc/min until 250 cc of standard had entered the cryotrap. The contents of the cryotrap were then desorbed onto the GC column as previously described.

Figure 17 illustrates a total ion (RIC) chromatogram obtained from cryotrapping two aliquots of the 5 cc loop (nominally 8.14 ng/component). As indicated earlier, the quantitation mass areas were used to compute a response for each compound in units of area/nanogram injected. Since the INCOS program QUAN is designed solely for an internal standard quantitation environment, a simple INCOS compatible Fortran program was developed to insert a dummy constant internal standard area into the quantitation list. This area corresponded to a library entry containing a constant amount. The response factor for the standards was calculated by QUAN as

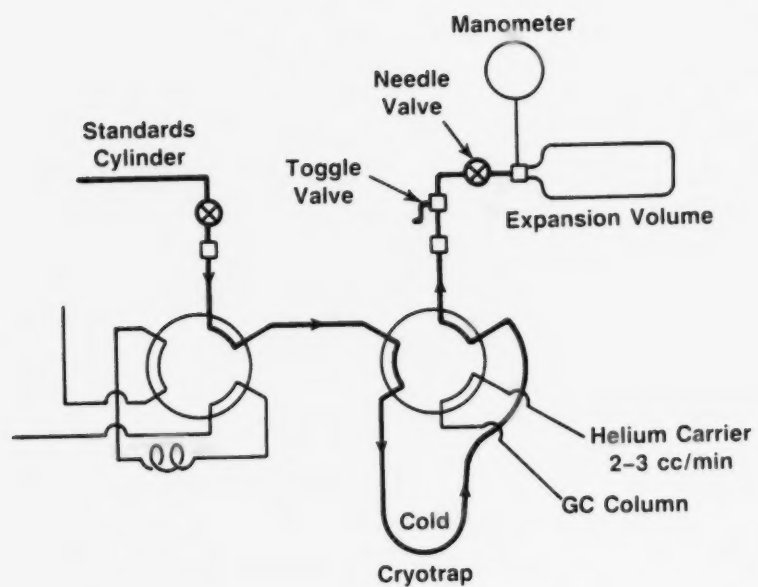


Figure 16. Sampling configuration for high level calibration standard.

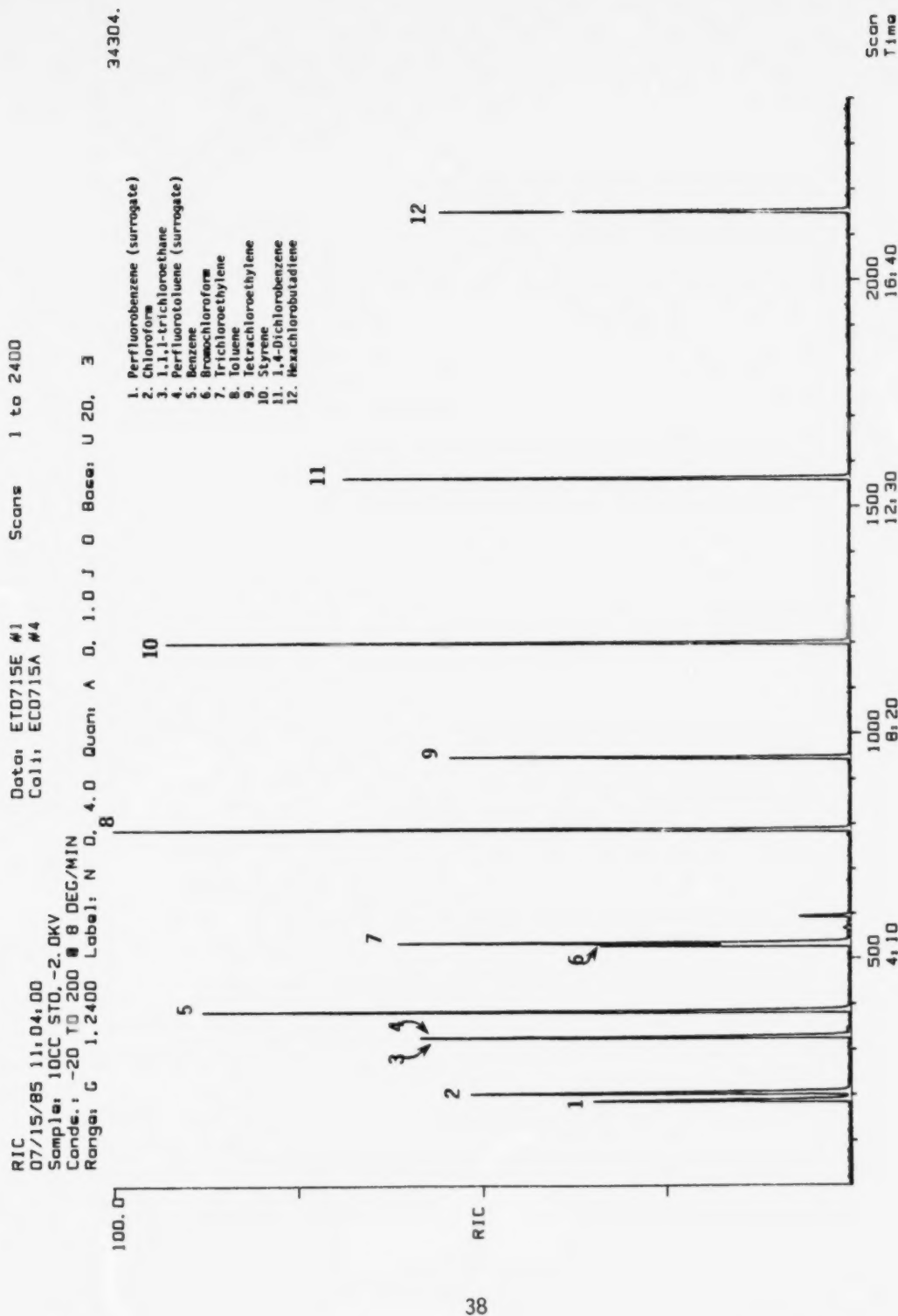


Figure 17. Total ion chromatogram from a low level calibration standard.

$$RF_i = \frac{(A_i)(Amt_{IS})}{(A_{IS})(Amt_i)} = \frac{(A_i)(C)}{Amt_i}$$

where A_i = quantitation mass area for compound i

Amt_i = library amount for compound i

$$C = \frac{Amt_{IS}}{A_{IS}}$$

A_{IS} and Amt_{IS} = constant area and amount of internal standard

The same approach was applied to unknowns using the dummy internal standard. The amount of each compound in the unknown was calculated by QUAN as

$$Amt_i = \frac{(A_i)(Amt_{IS})}{(A_{IS})(RF_i)} = \frac{(A_i)(C)}{RF_i}$$

Since RF_i contains the same constant, the numerical quantities associated with the internal standard factor out of the expression providing a capability for automated data processing based on external standards.

In order to compare the equivalence of expansion volume sampling of the high volume standard cylinder vs. the 5 cc loop, duplicate analyses were performed with one and four injections of the 5 cc loop as well as 62.5 cc and 125 cc via the expansion volume apparatus at a fixed electron multiplier voltage. The linear regression of these eight analyses are illustrated in Figure 18 for benzene and Figure 19 for hexachlorobutadiene. It is of interest that the styrene and 1,4-dichlorobenzene demonstrated response curves nearly equivalent to that shown for hexachlorobutadiene, while the remaining (earlier eluting) compounds exhibited the somewhat increased scatter illustrated by benzene. The reason for this is yet unclear, particularly since the percent of total ion current carried by the hexachlorobutadiene quantitation mass was significantly less than the other compounds in the study. The response for the semivolatile hexachlorobutadiene illustrates reproducible and efficient transfer of the target compounds through the sampling system as well as the comparability of the high and low volume calibration techniques.

Response Lib, 1A, 6; Mass: 78 (Ref. comp: 1A, 1; Mass: 100)
 Cap: BENZENE
 Ref: DUMMY INTERNAL STANDARD
 Area (Av: 135739.)

Drift= 2414.980
 Scatter= 5741.690
 X Scatter= 4.230

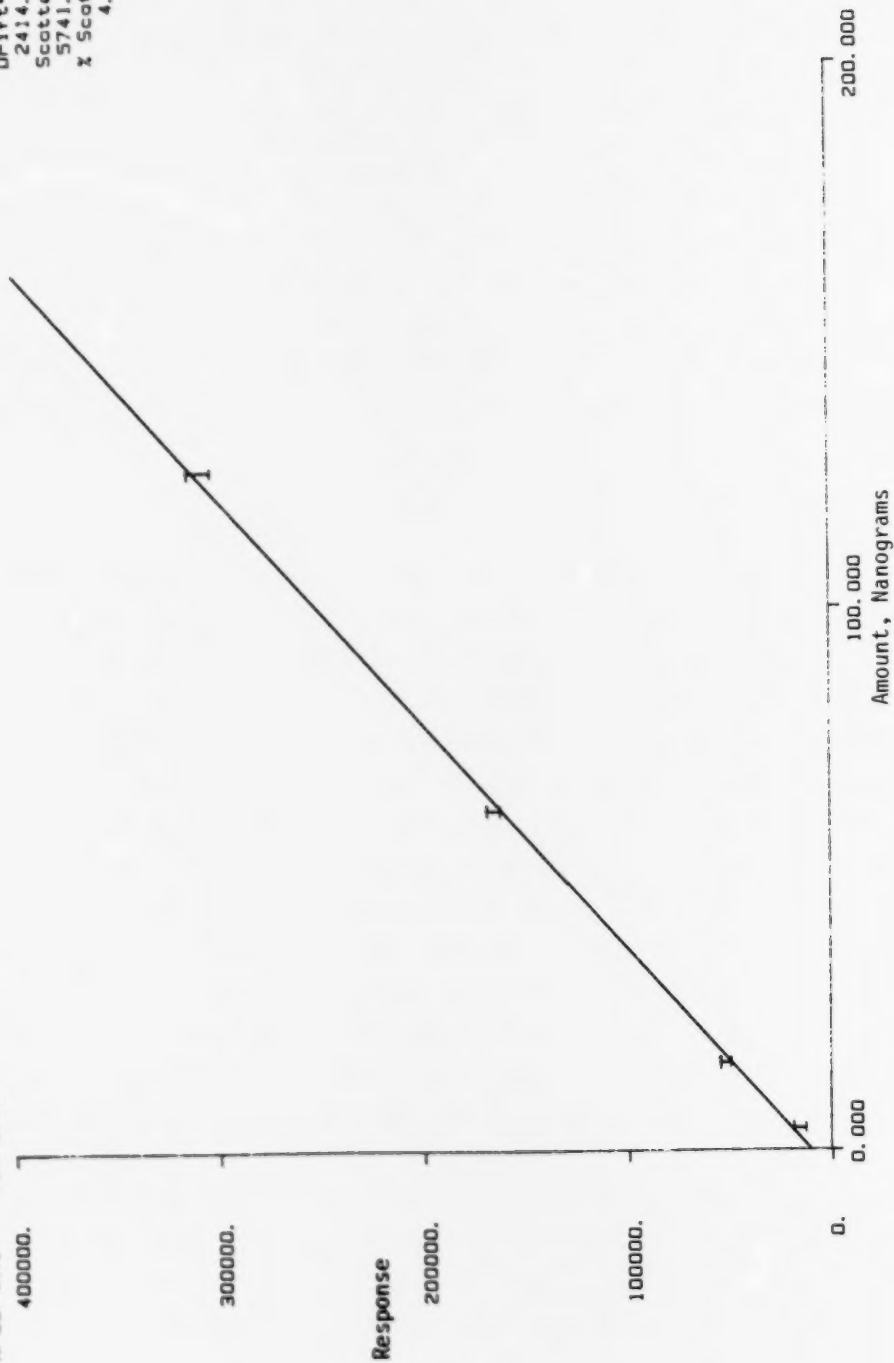


Figure 18. Response linearity of benzene.

Response Lib, 1A, 13, Mass: 225 (Ref. comp: 1A, 1; Mass: 100)
 Cmp: HEXACHLOROBUTADIENE
 Ref: DUMMY INTERNAL STANDARD
 Area (Av: 23875.)

Drift= 223.365
 Scatter= 489.976
 X Scatter= 2.052



Figure 19. Response linearity of hexachlorobutadiene.

Analysis of the Distributed Air Volume Samples

The distributed air volume (DAV) sample analyses were carried out by thermal desorption of the Tenax traps at 200°C for 10 minutes while purging with helium at 80 ml/min. The DAV sample analysis configuration is illustrated in Figure 20. Following thermal desorption, the contents of the cryotrap were desorbed onto the GC column as previously described. A typical total ion chromatogram of a 10 liter DAV sample of house air nominally spiked with 27 ng/l of the target compounds is illustrated in Figure 21. The DAV samples were not purged with helium at room temperature prior to cryotrapping. The tubes were, however, purged with helium for approximately one minute prior to insertion into the clamshell oven. Water retention on the Tenax resulted in chromatographic splitting of chloroform at the higher sample volumes of 20 and 40 liters. In these cases, the quantitation mass areas for the split chloroform peaks were summed manually prior to final computation of amounts. No other chromatographic anomalies were observed due to the residual water. No evidence of cryotrap or chromatographic column plugging was observed during the study.

Analysis of the Passive Sampling Device (PSD) samples

The high and low rate PSDs were thermally desorbed in the same manner as that illustrated in Figure 20 for the DAV samples. A low dead-volume screw closure stainless steel PSD desorber was substituted for the Nutech clamshell oven. After reaching a temperature of 150°C, the PSDs were desorbed for 15 minutes while purging with helium at 80 ml/min. The lower temperature was employed for the PSDs to minimize loss of the target compounds due to reaction with hot stainless steel. Preliminary studies indicated losses of 80 percent for 1,1,1-trichloroethane and 35-45 percent for chloroform and bromodichloromethane when the cylinder standards were subjected to brief exposures to stainless steel at 250°C. Since temperature regulation of the PSD desorber was less certain than the clamshell oven, the lower temperature of 150°C was used to provide a sufficient safety margin. No degradation of cylinder standards was apparent when exposed to stainless steel at 150°C.

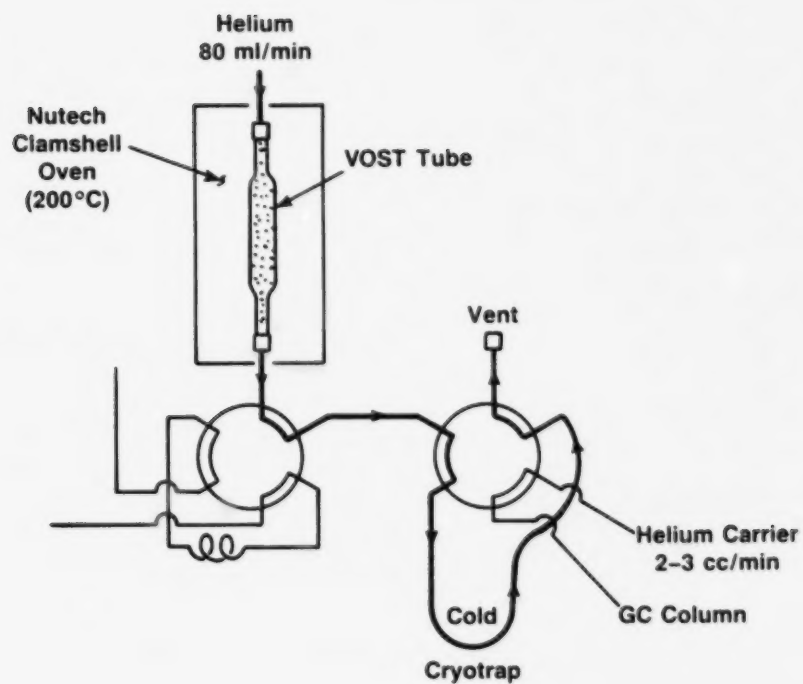


Figure 20. Desorption and trapping configuration for DAV Tenax tubes.

RIC
 07/17/85 10:45:00
 Sample: IAS TENAX TRAP-23(10L). 7/11/85
 Conds.: -20 TO 200 ° 8 DEG/MIN
 Range: C 1.2400 Label: N D. 4.0 Quan: A D. 1.0 J 0 Base: U 20. 3
 Data: ET0717E #1
 Coll: EC0717A #3
 Scans 1 to 2400
 48832.

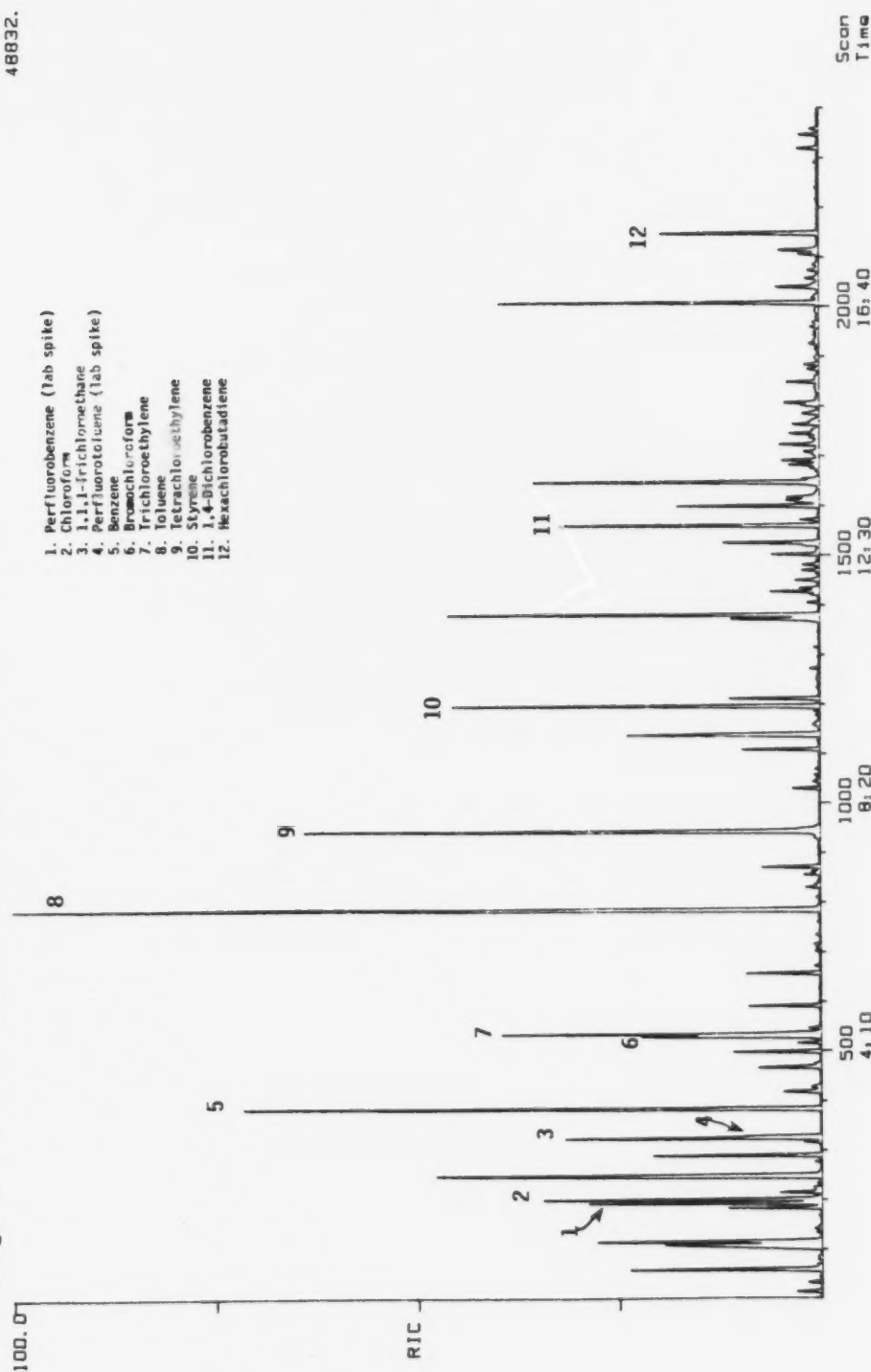


Figure 21. Total ion chromatogram from a DAV sample of spiked indoor air.

Analysis of the Canister Samples

The inlet configuration used for canister analysis is illustrated in Figure 22. The canister was attached to approximately one meter of Nafion tubing whose exterior surface was swept continuously with clean, dry air from an AADCO air generator. The Nafion was used to lower the water vapor concentration of the samples to permit direct cryogenic trapping of 1.0 liter samples. The exit of the Nafion dryer was attached to the same inlet fitting as the DAV and PSD sampling devices. The expansion volume apparatus described previously for the high level calibration was used to sample 1.0 liters through the cryotrap at a rate of 80 ml/min. Leak checking and flushing operations were identical to those described for the high volume calibration procedure. Following cryotrap collection, the cryotrap was desorbed at 160°C in a manner identical to that used for calibration, DAV and PSD analyses.

Quality Assurance

In order to validate the assumed concentration of the standards cylinder, an NBS standard cylinder (CAL-5709) containing 0.254 ppmv of benzene in nitrogen was analyzed in a manner identical to that used for the cylinder standard. Two analyses of the Battelle standards cylinder were made by twice filling the 5 cc loop as in the low volume calibration. The NBS standard cylinder was then substituted for the Battelle standards cylinder. Two analyses of the NBS standard were then conducted by twice filling the 5 cc loop.

The assumed concentration of benzene in the Battelle standard is 1.00 ng/cc at 25°C and 1 atm. The expected concentration of benzene in the NBS cylinder is 0.810 ng/cc at 25°C and 1 atm. A summary of the data obtained from these four analyses is shown in Table 5. Using an average response for the duplicate Battelle cylinder and NBS cylinder analyses, the measured concentration of the NBS cylinder was 0.865 ng/cc resulting in an error of +6.8 percent. Although the NBS standard is assumed to be correct, Table 5 is organized in such a manner as to project the error in sample analyses based on Battelle's standard. Since this experiment tested only one of 12 components, this correction was not applied to the data accumulated during the study.

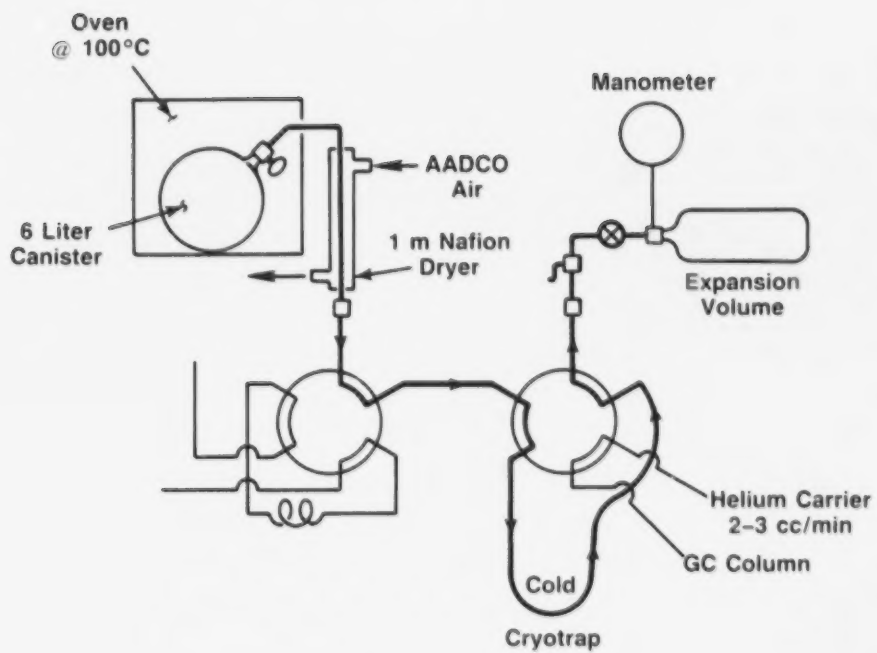


Figure 22. Trapping configuration for canisters.

TABLE 5. VALIDATION OF BATTELLE STANDARD
CYLINDER FOR BENZENE

	Average Area, m/z 78*	Predicted (ng/cc)	Measured (ng/cc)	Percent Error
NBS Standard	48445	0.810	0.865	+6.8
Battelle Standard	56010	1.00	--	--

* Raw area, arbitrary units.

During the course of the analytical effort, two audit cylinders were received from Research Triangle Institute (RTI). In order to test the entire system in a manner closely resembling the actual analytical procedure, the cylinders were treated in the same manner as the canisters, except that the audit cylinders were not heated and a smaller volume (250 cc at 25°C, 1 atm) was sampled. Calibration of the system involved introduction of two aliquots of the Battelle standard cylinder via the heated 5 cc loop. Data reported earlier to RTI did not include the temperature correction of the 5 cc loop volume, resulting in audit cylinder values that were artificially elevated.

The corrected results for the two audit cylinders are summarized in Table 6. Only those compounds that were common to the target set for this study are shown. In the case of chloroform, trichloroethylene and tetrachloroethylene, the deviation between Battelle's analyses and the reference analyses is within the standard deviation of Battelle's replicates.

TABLE 6. ANALYSIS OF AUDIT CYLINDERS (ppbv)

Compound	Audit Cylinder AAL - 11952					
	Trial 1*	Trial 2*	Trial 3*	Avg. $\pm$ RSD	Avg. ppbv	Actual ppb (RTI) Deviation
Chloroform	51.6	53.3	58.6	54.5 $\pm$ 6.7%	44.7	43.9 + 1.8%
Benzene	16.1	16.1	16.2	16.1 $\pm$ 0.3%	20.2	19.9 + 1.5%
Tetrachloroethylene	17.2	17.8	18.3	17.8 $\pm$ 3.1%	10.5	10.3 + 1.9%
Compound	Audit Cylinder AAL - 12420					
	Trial 1*	Trial 2*	Trial 3*	Avg. $\pm$ RSD	Avg. ppbv	Actual ppb (RTI) Deviation
1,1,1 Trichloroethane	20.4	21.9	21.3	21.2 $\pm$ 3.6%	15.6	14.8 + 5.4%
Trichloroethylene	18.4	20.1	20.8	19.8 $\pm$ 6.2%	14.7	15.1 - 2.6%

* ng/250 cc at 25°C, 1 atm.

SECTION 4

RESULTS

Ten experiments were carried out in an unoccupied residence to intercompare the various volatile organic compound sampling techniques. Two of the experiments involved measurements on background air in the test residence. The remaining 8 experiments employed spiking of the target compounds into the residence. The dates of the 10 experiments and the nominal spike levels are shown in Table 7. Some of the target compounds were present in the background air in the residence, contributing significantly to the total residence concentration during the spiking experiments.

TABLE 7. NOMINAL SPIKE LEVELS FOR INDOOR
INTERCOMPARISON EXPERIMENTS

Experiment No.	Date	Nominal Spike Level (ng/l)
1	June 12, 1985	background
2	June 18, 1985	3
3	June 24, 1985	3
4	June 26, 1985	9
5	July 1, 1985	9
6	July 8, 1985	27
7	July 10, 1985	27
8	(Experiment aborted)	--
9	August 20, 1985	background
10	September 23, 1985	3
11	September 30, 1985	9

The results from the 10 intercomparison experiments are provided in Tables 8 through 17. The tables list the experiment number, date, spike level, measured air exchange rate, average temperature, average relative humidity, and the mean NO and NO₂ concentrations over the 12 hour sampling period. Tables 8 through 17 also report the sample volumes, blank-corrected concentrations, and blank values for the various sampling techniques.

Experiments 9 and 10 were conducted with purposely higher temperature and relative humidity.

TABLE 8. RESULTS FROM INDOOR INTERCOMPARISON STUDY EXPERIMENT 1

Experiment No. 1
Date: June 12, 1985

Average Temperature, °C 25°
Average Relative Humidity, percent 42
Average [NO], ppb 20
Average [NO₂], ppb <5

Organic Spike Level: Background
Measured Air Exchange Rate: 0.149 hr⁻¹

Sampling Techniques			Target Chemicals									
			Chloroform	1,1,1-Trichloroethane	Tetrachloroethene	Bromodichloroethene	Trichloroethene	Benzene	Toluene	Styrene	p-Dichlorobenzene	Hexachlorobutadiene
Automated Cryogenic Gas Chromatograph	Sample No.	Sample Volume, l	Reported Units									
Integrated Canister--Sample 1 Integrated Canister--Sample 2	--	0.15	ng/l	<0.1	6.8	15.5	NR	NR	5.8	9.3	<0.5	<0.1
	C-1	1.0	ng/l	<0.3	2.5	12.8	<0.3	<0.5	10.7	8.6	<0.2	2.1
	C-1	1.0	ng/l	<0.3	2.5	12.7	<0.3	<0.5	10.9	8.7	<0.2	<0.2
Distributed Air Volume--System 1 Distributed Air Volume--System 1 Distributed Air Volume--System 1 Distributed Air Volume--System 1	I-10	5.24	ng/l	0.2	1.3	9.4	<0.1	0.2	1.9	6.9	0.4	1.3
	I-1	10.44	ng/l	0.3	1.4	8.9	<0.1	<0.1	1.6	5.9	0.4	1.1
	I-5	14.89	ng/l	0.4	2.3	13.8	<0.1	<0.1	2.4	9.0	0.5	0.4
	I-9	19.70	ng/l	0.4	2.4	14.8	0.2	0.2	2.5	9.5	0.5	0.8
Distributed Air Volume--System 2 Distributed Air Volume--System 2 Distributed Air Volume--System 2 Distributed Air Volume--System 2	I-12	2.13	ng/l	<0.5	1.9	14.1	<0.1	<0.1	2.8	10.3	0.5	1.4
	I-13	6.77	ng/l	0.7	3.1	21.7	<0.1	0.3	3.7	14.2	0.9	2.8
	I-6	13.26	ng/l	0.2	2.3	13.0	<0.1	0.2	2.3	8.8	0.4	<0.5
	I-8	18.90	ng/l	0.3	2.5	15.9	<0.1	<0.1	2.6	10.2	0.6	<0.6
DAV Blank	I-2		ng	--	0.8	--	--	--	0.2	0.1	--	--
DAV Blank	I-4		ng	--	0.6	--	--	--	0.3	0.1	--	--
High Rate Passive Sampler High Rate Passive Sampler High Rate Passive Sampler	72	*	ng/l	<0.1	3.8	5.6	<0.3	0.2	3.0	9.1	<0.1	<1.4
	60	*	ng/l	0.4	5.2	21.2	<0.3	0.4	3.4	12.4	0.8	3.3
	73	*	ng/l	0.4	5.2	20.7	<0.3	0.3	3.2	12.4	0.8	2.2
HRPS Blank	78		ng	--	15.5	--	--	1.0	1.0	2.0	--	--
Low Rate Passive Sampler Low Rate Passive Sampler Low Rate Passive Sampler	B203	*	ng/l	<0.2	6.6	5.1	<0.2	0.7	1.7	4.3	<0.1	1.4
	B202	*	ng/l	<0.2	5.6	4.5	<0.2	0.6	1.6	3.8	<0.1	1.0
		*	ng/l									
LRPS Blank	B210		ng	0.1	10.0	0.2	<0.4	1.0	1.0	1.4	0.2	0.1
NA Not available NA Not reported due to interference or high blank	*Sampling rate for PSDs varies with compound. Sample volume for 12 hour collection period, in liters,		High Rate PSD	8.3	5.2	36.2	28	16.6	17.9	40.3	46	41
			Low Rate PSD	1.80	1.53	1.86	1.70	1.89	2.01	1.92	1.81	1.53
												1.25

TABLE 9. RESULTS FROM INDOOR INTERCOMPARISON STUDY EXPERIMENT 2

Experiment No. 2
 Date: June 18, 1985
 Organic Spike Level: Low
 Measured Air Exchange Rate: 0.104 hr⁻¹
 Average Temperature, °C 25.5
 Average Relative Humidity, percent 41
 Average [H₂], ppb 10
 Average [H₂O], ppb <5

Sampling Techniques						Target Chemicals									
						Chloroform	1,1,1-Trichloroethane	Tetrachloroethene	Bromodichloromethane	Trichloroethene	Benzene	Toluene	Styrene	p-Dichlorobenzene	Hexachlorobutadiene
Sample No.	Sample Volume, l	Reported Units													
Automated Cryogenic Gas Chromatograph															
--	0.15	ng/l	6.1	12.1	16.1	NR	NR	22.5	57.8	4.1	3.6	4.9			
Integrated Canister--Sample 1															
C-2	1.0	ng/l	3.8	4.8	13.1	2.5	2.2	17.1	48.4	1.8	4.0	2.5			
Integrated Canister--Sample 2															
C-2	1.0	ng/l	4.0	5.2	13.1	2.6	2.5	18.0	50.3	1.9	4.2	3.1			
Distributed Air Volume--System 1															
T-4	4.99	ng/l	3.3	5.2	13.2	2.2	1.8	18.7	55.6	2.2	3.8	<1.0			
Distributed Air Volume--System 1															
T-15	10.27	ng/l	3.3	4.5	12.8	2.4	1.8	18.0	54.8	2.2	3.5	<1.0			
Distributed Air Volume--System 1															
T-14	13.97	ng/l	3.2	4.9	13.1	2.4	1.9	18.7	54.8	2.1	2.2	<1.0			
Distributed Air Volume--System 1															
T-9	19.42	ng/l	3.0	4.4	11.3	2.3	1.6	16.8	46.0	1.8	2.9	<1.0			
Distributed Air Volume--System 2															
T-10	4.72	ng/l	3.0	4.4	12.8	2.1	1.8	16.6	53.4	2.1	3.6	<1.0			
Distributed Air Volume--System 2															
T-1	9.28	ng/l	3.1	4.5	11.2	2.1	1.7	17.4	51.2	2.0	1.7	<1.0			
Distributed Air Volume--System 2															
T-7	13.39	ng/l	2.9	4.1	11.5	2.1	1.7	16.3	47.5	1.9	3.2	<1.0			
Distributed Air Volume--System 2															
T-8	18.80	ng/l	3.1	4.3	12.4	2.2	1.9	16.4	48.0	1.9	3.3	1.0			
DAV Blank															
I-11		ng	--	--	--	--	--	0.4	3.0	--	--	--			
DAV Blank															
I-12		ng	--	--	--	--	--	0.9	0.2	--	--	--			
High Rate Passive Sampler															
74	*	ng/l	1.8	NR	20.6	2.0	2.1	20.9	71.0	2.7	5.3	<1.4			
High Rate Passive Sampler															
78	*	ng/l	1.9	NR	19.0	1.8	2.1	20.0	60.1	3.0	5.6	2.1			
High Rate Passive Sampler															
	*	ng/l													
HRPS Blank															
72		ng	0.5	72.3	--	--	3.8	2.4	7.6	0.7	1.0	--			
Low Rate Passive Sampler															
B206	*	ng/l	3.1	NR	10.2	3.0	2.1	19.4	38.1	1.2	2.5	<1.1			
Low Rate Passive Sampler															
B203	*	ng/l	1.8	NR	6.3	1.5	1.3	8.6	21.9	1.1	3.0	1.2			
Low Rate Passive Sampler															
	*	ng/l													
LRPS Blank															
B211		ng	<0.1	38.1	0.1	<0.4	1.0	1.7	2.0	0.6	0.3	<1.8			
*Sampling rate for PSDs varies with compound. Sample volume for 12 hour collection period, in liters;															
NA Not available															
NR Not reported due to interference or high blank															

*Sampling rate for PSDs varies with compound. Sample volume for 12 hour collection period, in liters.

TABLE 10. RESULTS FROM INDOOR INTERCOMPARISON STUDY EXPERIMENT 3

Experiment No. 3

Date: June 24, 1985

Organic Spike Level: Low

Measured Air Exchange Rate: 0.085 hr⁻¹

Average Temperature, °C 26⁵
 Average Relative Humidity, percent 37
 Average [NO], ppb 15
 Average [NO₂], ppb <5

Sampling Techniques			Target Chemicals									
Sample No.	Sample Volume, l	Reported Units	Chloroform	1,1,1-Trichloroethane	Tetrachloroethylene	Bromodichloroethane	Trichloroethylene	Benzene	Toluene	Styrene	p-Dichlorobenzene	Hexachlorobutadiene
Automated Cryogenic Gas Chromatograph												
--	0.15	ng/l	5.7	15.2	23.1	NR	NR	13.8	24.4	3.0	4.0	5.3
Integrated Canister--Sample 1	C-3	ng/l	2.4	4.7	15.2	1.6	1.7	9.2	17.9	1.4	3.0	<1.4
Integrated Canister--Sample 2	C-3	ng/l	2.9	5.6	18.7	1.5	1.8	9.7	20.8	1.5	3.8	1.4
Distributed Air Volume--System 1	I-16	ng/l	2.5	5.4	20.8	1.7	1.7	9.2	27.3	2.3	4.2	<1.0
Distributed Air Volume--System 1	I-15	ng/l	2.6	6.1	21.6	1.9	1.9	10.3	26.8	2.4	4.1	1.2
Distributed Air Volume--System 1	I-10	ng/l	2.9	5.8	21.4	1.7	1.7	9.0	25.3	2.4	4.1	1.3
Distributed Air Volume--System 1	I-21	ng/l	2.4	5.3	20.4	1.5	1.7	9.2	24.2	2.1	3.9	1.3
Distributed Air Volume--System 2	I-17	ng/l	2.4	5.2	20.9	1.6	1.7	9.4	25.7	2.3	4.2	0.9
Distributed Air Volume--System 2	I-18	ng/l	2.4	4.8	19.5	1.7	1.8	8.3	23.7	2.2	3.8	1.0
Distributed Air Volume--System 2	I-23	ng/l	2.6	5.3	20.0	1.9	1.8	8.9	24.7	2.3	4.0	1.2
Distributed Air Volume--System 2	I-22	ng/l	2.5	5.3	20.7	1.9	1.8	9.3	24.9	2.1	3.9	1.2
DAV Blank	I-9	ng	--	--	--	--	--	1.2	0.1	--	--	--
DAV Blank	I-12	ng	--	0.2	--	--	--	0.9	0.2	--	--	--
High Rate Passive Sampler	B7	ng/l	1.0	20.1	29.6	1.7	2.4	11.4	32.8	2.7	1.6	<1.4
High Rate Passive Sampler	B8	ng/l	1.0	19.8	30.9	1.6	2.4	11.5	33.7	2.4	<0.1	<1.4
HRPS Blank		ng	--	6.2	--	--	0.6	3.2	1.0	0.2	0.8	--
Low Rate Passive Sampler	B208	ng/l	1.5	1.8	9.4	1.0	0.9	4.1	11.0	1.3	3.0	1.1
Low Rate Passive Sampler	B204	ng/l	2.0	3.9	17.3	1.3	1.0	6.2	13.6	1.3	0.9	<1.1
Low Rate Passive Sampler	B202	ng/l	2.0	4.3	11.8	1.2	1.2	34.8	15.0	3.1	9.4	<1.1
LRPS Blank	B212	ng	0.1	3.1	<0.1	<0.4	1.1	0.9	0.6	0.1	0.1	<1.8
NA Not available		High Rate PSD	8.3	5.2	36.2	28	16.6	17.9	40.3	46	41	31.4
NR Not reported due to interference or high blank		Low Rate PSD	1.80	1.53	1.86	1.70	1.09	2.01	1.92	1.81	1.53	1.25
*Sampling rate for PSDs varies with compound. Sample volume for 12 hour collection period, in liters.												

TABLE 11. RESULTS FROM INDOOR INTERCOMPARISON STUDY EXPERIMENT 4

Experiment No. 4

Date: June 26, 1985

Average Temperature, °C: 25.5^a
Average Relative Humidity, percent: 37Organic Spike Level: Medium
Measured Air Exchange Rate: 0.149 hr⁻¹Average [H₂], ppb: 12
Average [H₂], ppb < 5

Target Chemicals

Sampling Techniques	Sample No.	Sample Volume, l	Reported Units	Chloroform	Trichloroethylene	Tetrachloroethylene	Methane	Trichloroethylene	Benzene	Toluene	Styrene	p-Dichlorobenzene	Hexachlorobenzene
Automated Cryogenic Gas Chromatograph	--	0.15	ng/l	10.7	20.4	36.2	NP	NP	13.3	22.0	5.3	5.5	12.6
Integrated Canister--Sample 1	C-2	1.0	ng/l	7.6	8.5	34.3	4.8	5.2	11.6	23.1	4.3	5.7	2.9
Integrated Canister--Sample 2	C-2	1.0	ng/l	6.8	8.5	34.3	4.5	4.8	10.5	22.1	3.7	5.5	3.2
Distributed Air Volume--System 1	T-13	5.03	ng/l	6.1	8.1	37.6	3.8	4.9	11.6	26.0	5.2	6.8	4.0
Distributed Air Volume--System 1	T-14	10.30	ng/l	5.8	7.8	36.2	4.3	4.9	10.8	23.6	5.0	6.7	5.1
Distributed Air Volume--System 1	T-19	13.20	ng/l	6.8	9.0	41.6	4.2	5.2	13.2	27.1	5.2	7.5	6.2
Distributed Air Volume--System 1	T-20	19.70	ng/l	6.1	8.2	38.1	4.4	4.6	10.6	24.6	4.6	5.0	<1.0
Distributed Air Volume--System 2	T-1	4.77	ng/l	5.3	7.2	46.7	3.5	4.0	9.6	20.5	4.3	5.7	3.7
Distributed Air Volume--System 2	T-4	9.63	ng/l	5.3	8.2	31.7	3.9	4.4	9.5	21.0	4.7	6.5	4.8
Distributed Air Volume--System 2	T-7	13.40	ng/l	6.4	8.1	36.3	3.9	5.1	11.7	23.4	4.8	6.6	5.1
Distributed Air Volume--System 2	T-8	19.20	ng/l	6.2	8.3	38.7	4.4	4.8	11.0	24.3	4.7	4.4	<1.0
UAV Blank	MCT-8	--	ng	--	--	--	--	--	1.8	1.4	0.1	--	--
DAV Blank	MCT-6	--	ng	--	--	--	--	--	2.5	1.2	--	--	--
High Rate Passive Sampler	72	*	ng/l	3.6	20.7	52.2	3.7	5.8	11.7	31.2	6.3	9.1	5.4
Low Rate Passive Sampler	73	*	ng/l	4.0	23.0	53.9	3.8	5.8	11.8	32.0	6.0	6.4	<1.4
High Rate Passive Sampler	76	--	ng	--	10.6	--	--	0.2	2.4	1.7	0.4	--	--
Low Rate Passive Sampler	B214	*	ng/l	3.2	4.6	18.3	2.4	2.3	6.0	11.8	2.6	3.9	2.0
Low Rate Passive Sampler	B213	*	ng/l	4.0	5.6	20.0	3.0	2.6	5.7	12.9	2.6	4.0	<1.1
Low Rate Passive Sampler	B216	--	ng	<0.1	4.5	<0.1	<0.4	0.3	1.3	0.9	0.2	<0.1	<1.8
NA Not available			High Rate PSD	8.3	5.2	36.2	28	16.6	17.9	40.3	46	41	31.4
NR Not reported due to interference or high blank			Low Rate PSD	1.80	1.53	1.86	1.70	1.89	2.01	1.92	1.81	1.53	1.25

*Sampling rate for PSDs varies with compound. Sample volume for 12 hour collection period, in liters;

TABLE 12. RESULTS FROM INDOOR INTERCOMPARISON STUDY EXPERIMENT 5

Experiment No. 5
Date: July 1, 1995

Organic Spike Level: Medium
Measured Air Exchange Rate: 0.044 hr⁻¹

Average Temperature, °C 25
Average Relative Humidity, percent 39
Average [H₂O], ppb 15
Average [NO₂], ppb <5

Sampling Techniques			Sample No.	Sample Volume, l	Reported Units	Target Chemicals												
						Chloroform	1,1,1-Trichloro-ethane	Tetrachloro-ethylene	Bromodichloro-methane	Trichloro-ethylene	Benzene	Toluene	Styrene	p-Dichloro-benzene	Hexachloro-			
Automated Cryogenic Gas Chromatograph						--	0.15	ng/l	12.7	23.2	51.7	NR	NR	14.5	22.7	5.7	6.0	11.9
Integrated Canister--Sample 1						C-2	1.0	ng/l	9.3	11.8	47.0	5.7	6.1	12.6	22.0	4.3	6.6	2.6
Integrated Canister--Sample 2						C-2	1.0	ng/l	8.9	11.0	44.1	5.3	5.5	11.8	20.7	4.2	5.9	2.8
Distributed Air Volume--System 1						T-12	5.14	ng/l	8.2	10.1	53.7	5.2	6.2	12.1	24.5	5.7	7.8	1.6
Distributed Air Volume--System 1						T-15	10.30	ng/l	8.0	9.8	51.3	5.2	6.0	11.8	23.5	5.0	6.9	3.2
Distributed Air Volume--System 1						T-16	13.30	ng/l	8.4	10.4	54.7	5.5	6.1	12.3	24.5	5.3	7.0	2.8
Distributed Air Volume--System 1						T-17	19.80	ng/l	7.4	9.6	50.9	5.0	5.4	10.4	22.3	4.7	6.3	3.3
Distributed Air Volume--System 2						T-18	4.79	ng/l	7.3	9.5	46.3	4.3	6.1	13.3	25.0	5.6	6.4	<1.0
Distributed Air Volume--System 2						T-21	9.27	ng/l	7.3	10.0	49.8	4.9	5.6	11.0	22.8	5.0	6.7	4.5
Distributed Air Volume--System 2						T-22	13.20	ng/l	7.9	9.8	51.6	4.7	5.5	11.8	23.5	5.1	6.6	5.6
Distributed Air Volume--System 2						T-23	19.10	ng/l	7.5	10.0	53.2	5.2	5.6	11.1	23.4	5.0	6.4	3.9
DAV Blank								ng	--	--	--	--	--	2.6	0.2	0.1	--	--
DAV Blank						T-9		ng	--	0.1	--	--	--	--	--	--	--	--
High Rate Passive Sampler						72	*	ng/l	5.3 ^b	22.1 ^a	1.8 ^a	0.7 ^a	4.7 ^a	12.2 ^a	2.2 ^a	<0.1 ^a	<0.1 ^a	<1.4 ^a
High Rate Passive Sampler						73	*	ng/l	5.5	23.1	60.5	3.8	8.0	13.5	28.5	4.8	<0.1 ^a	<1.4
High Rate Passive Sampler							*	ng/l										
LRPS Blank						76		ng	--	4.1	--	--	--	2.8	1.8	0.3	--	--
Low Rate Passive Sampler						B214	*	ng/l	5.5	7.8	24.8	3.9	3.9	7.9	11.4	2.5	3.2	<1.1
Low Rate Passive Sampler						B216	*	ng/l	5.2	6.9	22.5	3.7	3.8	7.0	10.6	2.0	3.1	<1.1
Low Rate Passive Sampler							*	ng/l										
LRPS Blank						B210		ng	<1	1.9	0.1	<0.4	0.5	1.4	1.3	0.2	<0.1	<1.8
NA Not available								High Rate PSD	8.3	5.2	36.2	28	16.6	17.9	40.3	46	41	31.4
NR Not reported due to interference or high blank								Low Rate PSD	1.80	1.53	1.86	1.70	1.89	2.01	1.92	1.81	1.53	1.25

a. Incomplete desorption suspected; suggest excluding this sample from statistical analysis.

*Sampling rate for PSDs varies with compound. Sample volume for 12 hour collection period, in liters;

TABLE 13. RESULTS FROM INDOOR INTERCOMPARISON STUDY EXPERIMENT 6

Experiment No. 6

Date: July 8, 1985

Organic Spike Level: High

Measured Air Exchange Rate: 0.045 hr⁻¹

Average Temperature, °C 27

Average Relative Humidity, percent 37

Average [H₂], ppb NAAverage [NO₂], ppb NA

Target Chemicals

Sampling Techniques	Sample No.	Sample Volume, l	Reported Units	Chloroform	1,1,1-Trichloro-ethane	Tetrachloro-ethylene	Bromodichloro-methane	Trichloro-ethylene	Benzene	Toluene	Styrene	p-Dichloro-benzene	Hexachloro-cyclopentadiene
Integrated Canister--Sample 1	C-3	1.0	ng/l	23.1	21.0	29.5	15.7	15.7	26.4	32.3	11.2	11.3	18.7
Integrated Canister--Sample 2	C-3	1.0	ng/l	23.8	20.7	30.3	15.9	16.0	27.9	33.7	11.6	11.8	17.0
Distributed Air Volume--System 1	I-20	5.22	ng/l	21.3	21.8	31.6	16.2	16.6	28.1	38.5	13.7	13.5	17.4
Distributed Air Volume--System 1	I-19	10.20	ng/l	22.8	19.8	29.4	15.9	15.5	26.3	36.6	13.4	12.8	18.3
Distributed Air Volume--System 1	I-13	19.62	ng/l	18.9	17.4	22.4	12.9	13.3	24.7	30.1	11.2	10.7	15.9
Distributed Air Volume--System 1	I-14	39.90	ng/l	11.9	15.0	27.6	14.0	13.7	25.5	34.1	12.0	11.6	18.0
Distributed Air Volume--System 2	I-1	4.78	ng/l	21.5	18.6	28.7	14.6	15.4	24.5	34.7	12.7	12.4	15.6
Distributed Air Volume--System 2	I-4	9.10	ng/l	17.7	16.0	24.4	11.1	11.8	21.6	29.7	11.3	11.2	16.5
Distributed Air Volume--System 2	I-8	18.90	ng/l	18.6	17.1	25.7	12.6	13.4	25.1	32.6	11.7	11.2	16.7
Distributed Air Volume--System 2	I-7	39.80	ng/l	10.0	15.1	28.1	13.4	14.9	25.1	31.7	12.1	11.9	18.6
DAV Blank	MCI-1		ng	--	0.3	--	--	--	3.1	0.2	--	0.6	--
DAV Blank	MCI-2		ng	--	0.3	--	--	--	6.5	0.1	0.1	--	--
High Rate Passive Sampler	87	*	ng/l	15.9	57.6	39.2	13.3	19.0	18.9	47.3	16.9	18.5	24.6
High Rate Passive Sampler	90	*	ng/l	15.7	56.7	43.0	13.2	20.3	21.0	50.5	17.5	19.4	31.4
High Rate Passive Sampler		*	ng/l										
HRPS Blank	91		ng	--	26.8	--	--	0.9	0.8	3.4	0.3	--	--
Low Rate Passive Sampler	B208	*	ng/l	14.7	15.5	14.8	11.3	9.9	17.9	14.8	6.6	7.3	11.2
Low Rate Passive Sampler	B206	*	ng/l	15.2	15.5	15.9	11.8	10.7	18.8	15.9	7.1	6.6	11.1
Low Rate Passive Sampler		*	ng/l										
LRPS Blank	B211		ng	-0.1	6.8	0.2	-0.1	1.0	1.2	2.0	0.2	0.1	1.8
MA Not available			High Rate PSD	8.3	5.2	36.2	28	16.6	17.9	40.3	46	41	31.4
HR Not reported due to interference or high blank			Low Rate PSD	1.80	1.53	1.86	1.70	1.89	2.01	1.92	1.81	1.53	1.25

*Sampling rate for PSDs varies with compound. Sample volume for 12 hour collection period, in liters.

TABLE 14. RESULTS FROM INDOOR INTERCOMPARISON STUDY EXPERIMENT 7

Experiment No. 7
 Date: July 10, 1985
 Organic Spike Level: High
 Measured Air Exchange Rate: 0.079 hr⁻¹
 Average Temperature, °C: 25.5
 Average Relative Humidity, percent: 39
 Average [NO], ppb: NA
 Average [NO₂], ppb: NA

Target Chemicals

Sampling Techniques	Sample No.	Sample Volume, l	Reported Units	Target Chemicals									
				Chloroform	1,1,1-trichloro-ethane	tetrachloro-ethylene	bromodichloro-methane	trichloro-ethylene	benzene	toluene	styrene	p-dichloro-benzene	hexachloro-cyclopentadiene
Automated Cryogenic Gas Chromatograph	--	0.15	ng/l	32.5	47.5	41.1	NR	NR	27.8	34.8	15.0	12.2	36.9
Integrated Canister--Sample 1	C-3	1.0	ng/l	25.7	22.4	37.5	18.1	18.6	23.2	32.7	16.2	14.4	22.0
Integrated Canister--Sample 2	C-3	1.0	ng/l	25.1	22.1	38.2	18.1	18.5	23.0	33.0	15.8	14.3	22.9
Distributed Air Volume--System 1	I-16	5.22	ng/l	28.7	24.7	36.8	16.7	17.4	27.4	34.5	15.4	14.5	19.9
Distributed Air Volume--System 1	I-18	10.20	ng/l	26.6	21.3	36.8	16.1	17.2	26.4	36.9	15.4	14.1	21.1
Distributed Air Volume--System 1	I-22	19.60	ng/l	17.6	20.3	38.5	15.8	17.6	26.2	36.8	15.0	14.3	21.7
Distributed Air Volume--System 1	I-21	39.90	ng/l	11.4	16.6	39.1	15.5	16.6	26.3	34.6	15.0	14.5	24.1
Distributed Air Volume--System 2	I-27	4.78	ng/l	28.7	24.1	35.8	15.7	16.2	11.1	34.7	14.5	14.3	18.2
Distributed Air Volume--System 2	I-23	9.89	ng/l	24.9	21.8	33.0	15.0	15.5	25.3	33.1	14.0	13.4	19.7
Distributed Air Volume--System 2	I-30	19.00	ng/l	25.0	10.0	38.2	16.5	18.4	27.0	38.1	15.4	14.7	22.4
Distributed Air Volume--System 2	I-29	39.40	ng/l	12.3	17.1	33.2	15.2	17.8	26.9	30.1	15.0	13.3	22.3
DAV Blank	I-9		ng	---	0.9	---	---	---	0.8	0.8	0.1	0.4	---
DAV Blank			ng										
High Rate Passive Sampler	73	*	ng/l	15.6	54.7	55.3	14.5	21.6	27.6	49.1	20.8	21.6	33.8
High Rate Passive Sampler	74	*	ng/l	13.5	56.8	59.7	14.8	23.6	28.1	52.6	21.4	23.9	38.5
High Rate Passive Sampler		*	ng/l										
HRPS Blank	78		ng	---	12.0	---	---	---	1.0	1.9	---	---	---
Low Rate Passive Sampler	B202	*	ng/l	16.1	16.3	22.6	12.2	11.1	14.3	19.8	9.8	11.2	16.5
Low Rate Passive Sampler	B210	*	ng/l	16.6	16.6	22.5	14.3	12.8	16.5	20.2	8.5	9.6	14.1
Low Rate Passive Sampler		*	ng/l										
LRPS Blank	B214		ng	0.1	7.6	0.3	0.4	0.6	0.9	1.6	0.2	0.4	1.8
NA Not available			High Rate PSD	8.3	5.2	36.2	28	16.6	17.9	40.3	46	41	31.4
NR Not reported due to interference or high blank			Low Rate PSD	1.80	1.53	1.86	1.70	1.89	2.01	1.92	1.61	1.53	1.25

*Sampling rate for PSDs varies with compound. Sample volume for 12 hour collection period, in liters.

TABLE 15. RESULTS FROM INDOOR INTERCOMPARISON STUDY EXPERIMENT 9

Experiment No. 9

Date: August 20, 1985

Organic Spike Level: Background

Measured Air Exchange Rate: 0.134 hr⁻¹

Average Temperature, °C 30

Average Relative Humidity, percent 43

Average [NO], ppb NA

Average [NO₂], ppb NA

Target Chemicals

Sampling Techniques	Sample No.	Sample Volume, l	Reported Units	Target Chemicals									
				Chloroform	1,1,1-Trichloroethane	Tetrachloroethene	Bromodichloromethane	Trichloroethene	Benzene	Toluene	Styrene	p-Dichlorobenzene	Hexachlorobutadiene
Automated Cryogenic Gas Chromatograph	--	0.15	ng/l	3.1	8.0	41.2	NR	NR	7.2	7.6	<0.5	3.2	2.8
Integrated Canister--Sample 1	C-1	1.0	ng/l	1.4	3.6	36.1	0.3	0.5	6.3	7.4	0.7	3.0	<1.4
Integrated Canister--Sample 2	C-1	1.0	ng/l	1.4	3.3	35.5	0.4	0.6	6.1	7.2	0.7	3.1	<1.4
Distributed Air Volume--System 1	I-23	4.95	ng/l	1.1	3.1	47.1	0.2	0.2	4.4	7.6	0.9	4.0	<1.0
Distributed Air Volume--System 1	I-26	10.35	ng/l	1.1	0.7	42.7	0.2	0.3	4.6	7.7	1.0	4.1	<1.0
Distributed Air Volume--System 1	I-30	20.46	ng/l	0.9	2.3	41.6	0.2	0.3	4.4	6.7	1.1	3.9	<1.0
Distributed Air Volume--System 1	I-16	40.09	ng/l	0.4	1.8	42.4	0.2	0.3	3.9	6.4	0.9	3.5	<1.0
Distributed Air Volume--System 2	I-27	4.99	ng/l	1.1	2.0	NA	0.1	0.2	3.2	NA	NA	3.3	<1.0
Distributed Air Volume--System 2	I-24	10.61	ng/l	0.9	2.0	32.3	0.1	0.2	0.5	5.5	0.9	3.6	1.0
Distributed Air Volume--System 2	I-22	19.12	ng/l	0.9	2.4	41.7	0.2	0.3	4.7	7.0	1.0	3.7	1.0
Distributed Air Volume--System 2	I-25	41.24	ng/l	0.4	1.7	38.8	0.3	0.3	3.5	6.1	0.9	3.5	<1.0
DAV Blank	I-15		ng	----	0.3	<0.1	----	----	9.7	0.7	0.1	----	----
DAV Blank	I-14		ng	----	----	----	----	----	8.7	0.6	0.1	0.3	----
High Rate Passive Sampler	73	*	ng/l	0.3	8.4	45.0	<0.3	<0.2	3.8	9.3	1.3	5.0	<1.4
Low Rate Passive Sampler	74	*	ng/l	0.4	8.5	47.2	<0.3	<0.2	3.9	9.4	1.3	4.9	<1.4
High Rate Passive Sampler		*	ng/l										
HRPS Blank	90		ng	0.1	12.6	0.2	----	19.1	4.4	7.3	0.8	2.1	----
Low Rate Passive Sampler	B206	*	ng/l	0.7	NR	14.8	0.2	<0.2	0.1	3.0	0.2	1.6	<1.1
Low Rate Passive Sampler	B208	*	ng/l	0.6	NR	15.5	0.2	<0.2	0.2	2.9	0.1	1.3	<1.1
Low Rate Passive Sampler		*	ng/l										
LRPS Blank	B214		ng	0.2	9.8	0.6	<0.4	3.3	5.7	1.6	0.9	1.7	<1.8
NA Not available			High Rate PSD	8.3	5.2	36.2	28	16.6	17.9	40.3	46	41	31.4
NR Not reported due to interference or high blank			Low Rate PSD	1.80	1.53	1.86	1.70	1.89	2.01	1.92	1.81	1.53	1.25

*Sampling rate for PSDs varies with compound. Sample volume for 12 hour collection period, in liters;

TABLE 16. RESULTS FROM INDOOR INTERCOMPARISON STUDY EXPERIMENT 10

Experiment No. 10

Date: September 23, 1985

Organic Spike Level: Low

Measured Air Exchange Rate: 0.212 hr⁻¹

Average Temperature, °C 26

Average Relative Humidity, percent 47

Average [H₂], ppb NAAverage [NO₂], ppb NA

Target Chemicals

Sampling Techniques	Sample No.	Sample Volume, l	Reported Units	Chloroform	1,1,1-Trichloroethane	Tetrachloroethene	Bromodichloromethane	Trichloroethene	Benzene	Toluene	Styrene	p-Dichlorobenzene	Hexachlorobutadiene
Automated Cryogenic Gas Chromatograph	--	0.15	ng/l	5.0	4.0	33.3	NR	NR	11.6	22.7	2.9	8.4	2.4
Integrated Canister--Sample 1	1-0	1.0	ng/l	2.4	5.1	32.2	1.7	2.4	8.9	20.7	1.5	3.8	1.6
Integrated Canister--Sample 2	1-0	1.0	ng/l										
Distributed Air Volume--System 1	1-27	4.70	ng/l	5.6	7.0	41.9	2.8	3.5	11.9	28.0	2.6	4.0	1.0
Distributed Air Volume--System 1	1-12	10.41	ng/l	4.8	5.3	36.8	2.7	3.1	10.2	24.9	2.7	4.0	1.2
Distributed Air Volume--System 1	1-1	20.37	ng/l	3.7	4.8	32.5	2.2	2.8	8.5	21.5	2.5	3.9	1.3
Distributed Air Volume--System 1	1-29	40.47	ng/l	1.1	3.5	32.6	2.5	2.8	7.8	20.3	2.4	3.7	1.6
Distributed Air Volume--System 2	1-15	5.00	ng/l	4.8	5.7	34.6	2.2	2.8	9.4	23.6	2.2	3.3	0.9
Distributed Air Volume--System 2	1-22	9.91	ng/l	4.0	4.6	29.1	2.1	2.5	8.2	19.5	2.0	3.1	0.6
Distributed Air Volume--System 2	1-8	19.29	ng/l	4.0	5.0	34.6	2.5	3.1	8.7	21.9	2.5	3.8	1.3
Distributed Air Volume--System 2	1-24	40.47	ng/l	1.4	3.5	30.6	1.9	2.3	7.6	20.2	2.3	3.6	1.6
DAV Blank	1-14		ng	---	1.4	---	---	---	2.7	1.1	1.0	3.4	---
DAV Blank	1-20		ng	---	1.7	---	---	---	3.0	1.3	4.0	NA	0.8
High Rate Passive Sampler	94	*	ng/l	1.1	10.0	35.9	1.2	2.0	8.0	23.5	2.9	4.9	2.4
High Rate Passive Sampler	88	*	ng/l	1.0	7.9	38.7	1.2	2.2	7.9	25.3	3.2	5.2	2.7
High Rate Passive Sampler		*	ng/l										
HRPS Blank	76		ng	---	21.9	---	---	1.4	1.7	2.1	0.5	1.3	---
Low Rate Passive Sampler	B212	*	ng/l	2.8	5.9	21.1	2.0	2.2	8.0	13.6	1.1	2.0	1.1
Low Rate Passive Sampler	B203	*	ng/l	2.5	7.2	16.6	1.7	2.5	7.1	10.7	1.0	1.4	<1.1
Low Rate Passive Sampler		*	ng/l										
LRPS Blank	B201		ng	<0.1	11.5	0.1	<0.4	1.4	0.7	1.2	0.1	0.1	<1.8
NA Not available				8.3	5.2	36.2	28	16.6	17.9	40.3	46	41	31.4
NR Not reported due to interference or high blank				1.80	1.53	1.86	1.70	1.89	2.01	1.92	1.81	1.53	1.25

*Sampling rate for PSDs varies with compound. Sample volume for 12 hour collection period, in liters.

TABLE 17. RESULTS FROM INDOOR INTERCOMPARISON STUDY EXPERIMENT 11

Average Temperature, °C 27
 Average Relative Humidity, percent 45
 Average [NO], ppb NA
 Average [NO₂], ppb NA

Experiment No. 11
 Date: September 30, 1985

Organic Spike Level: Medium
 Measured Air Exchange Rate: 0.210 hr⁻¹

Target Chemicals

Sampling Techniques	Sample No.	Sample Volume, l	Reported Units	Chloroform	1,1,1-Trichloroethane	Tetrachloroethylene	Bromodichloromethane	Trichloroethylene	Benzene	Toluene	Styrene	p-Dichlorobenzene	Hexachlorobutadiene
Automated Cryogenic Gas Chromatograph	--	0.15	ng/l	7.3	4.5	39.4	NR	NR	12.1	31.6	5.1	4.9	9.1
Integrated Canister--Sample 1	C-3	1.0	ng/l	5.9	10.4	33.7	4.0	4.0	11.6	26.5	3.8	4.8	5.3
Integrated Canister--Sample 2	C-3	1.0	ng/l	5.7	8.8	35.2	3.9	4.0	11.6	26.3	3.8	5.0	5.3
Distributed Air Volume--System 1	1-21	5.15	ng/l	6.9	11.0	40.6	4.5	4.5	13.0	36.2	4.6	5.6	4.7
Distributed Air Volume--System 1	1-16	10.54	ng/l	6.0	9.9	39.8	4.4	4.3	11.6	32.7	4.4	5.4	5.5
Distributed Air Volume--System 1	1-12	20.16	ng/l	4.1	8.5	36.7	3.8	3.8	10.4	29.0	4.0	4.9	5.1
Distributed Air Volume--System 1	1-19	40.38	ng/l	1.7	6.7	37.1	3.3	3.4	9.8	28.5	4.2	5.3	5.9
Distributed Air Volume--System 2	1-2	4.88	ng/l	6.5	9.2	42.6	4.7	4.6	12.0	37.6	4.8	5.9	4.6
Distributed Air Volume--System 2	1-5	9.49	ng/l	5.4	8.7	34.6	3.9	3.9	10.3	28.9	3.9	4.6	4.2
Distributed Air Volume--System 2	1-26	19.11	ng/l	4.0	8.6	38.0	3.9	4.0	11.0	30.3	4.6	6.2	5.8
Distributed Air Volume--System 2	1-30	40.04	ng/l	1.6	6.1	36.0	3.3	3.1	9.1	27.5	4.1	5.1	5.8
DAV Blank	1-9		ng	---	4.9	---	---	---	1.0	0.5	0.1	0.4	---
DAV Blank	1-25		ng	0.4	5.7	---	---	---	1.6	0.5	---	---	---
High Rate Passive Sampler	90	*	ng/l	1.7	18.2	39.5	2.1	2.8	7.8	29.5	4.8	6.6	7.5
High Rate Passive Sampler	76	*	ng/l	1.4	20.1	46.7	2.6	3.3	8.3	35.2	5.0	6.7	6.8
High Rate Passive Sampler	72		ng	---	19.8	---	---	---	0.6	1.2	2.5	---	---
HRPS Blank				---	---	---	---	---	---	---	---	---	---
Low Rate Passive Sampler	B203	*	ng/l	2.3	3.9	15.9	2.1	2.1	1.9	5.5	12.5	1.4	1.8
Low Rate Passive Sampler	B216	*	ng/l	2.8	3.8	19.1	2.6	2.2	2.2	6.4	14.7	1.5	2.2
Low Rate Passive Sampler	B212		ng	---	---	---	---	---	---	---	---	---	---
LRPS Blank				---	---	---	---	---	---	---	---	---	---
Sampling rate for PSDs varies with compound. Sample volume for 12 hour collection period, in liters:				8.3	5.2	36.2	28	16.6	17.9	40.3	46	41	31.4
High Rate PSD				1.80	1.53	1.86	1.70	1.89	2.01	1.92	1.81	1.53	1.25
Low Rate PSD				1.80	1.53	1.86	1.70	1.89	2.01	1.92	1.81	1.53	1.25

SECTION 5

DISCUSSION

The data from the indoor intercomparison experiments have been analyzed by statistical methods by Northrop Services. Linear regression techniques have been employed for these analyses. The statistical analysis is included as the appendix to this report. Justification for the regression analysis, details of the analysis, and a discussion of the results are included in the appendix. This section is a brief summary of the discussion provided in the appendix.

For purposes of the statistical analysis, the canister method was chosen as the reference method. This means that the results from the three Tenax methods (DAV, high rate PSD, and low rate PSD) were used as the dependent variables and the canister results as the independent variable in the regression. The canister and Tenax means were paired by experiment for each compound. The experimental design for the DAV Tenax was complicated by a number of factors and various types of averaging were done before performing the regression analysis. Details and justification for the regression analysis are given in the appendix.

The two statistics of greatest interest from the regression analysis are the slope of the Tenax vs. canister regression line and the correlation coefficient between the canister and Tenax means. The slope is interpreted as a measure of the agreement between the two methods in any comparison. If the intercept is 0, a slope less (greater) than one indicates that the Tenax mean is, generally, lower (higher) than the canister mean. A correlation coefficient close to one indicates that the canister and Tenax means are approximately linearly related over all experiments. That is, the resultant means from the measurements by the two methods show the same relative peaks and valleys over all experiments.

Figures 23, 25, and 26 are summaries of the slope (agreement) for all three Tenax methods, while Figure 24 shows the correlation coefficients for DAV Tenax for all compounds. The compound numbers on the horizontal

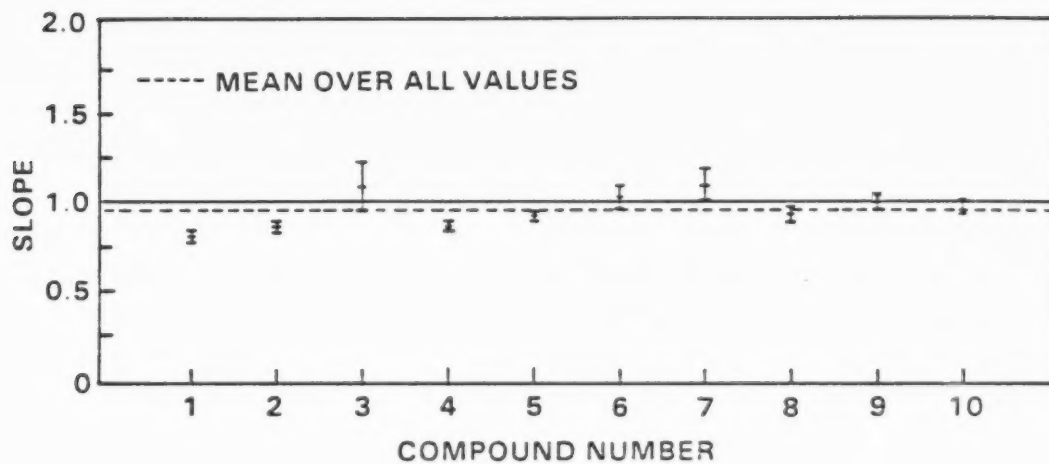


Figure 23. AGREEMENT: Tenax distributed air volume and canister slope plus and minus one standard error from the linear regression of Tenax mean vs canister mean.

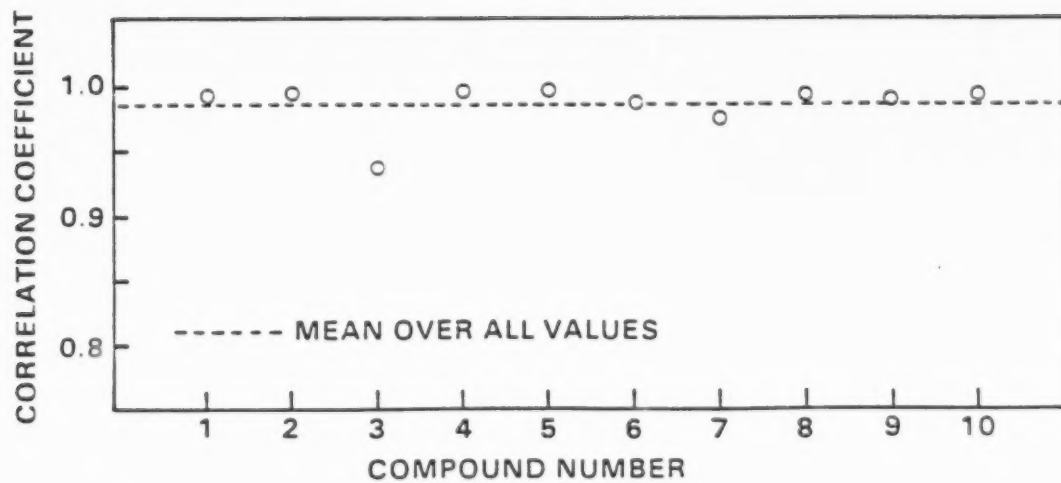


Figure 24. CORRELATION: Tenax distributed air volume and canister correlation of Tenax mean and canister mean.

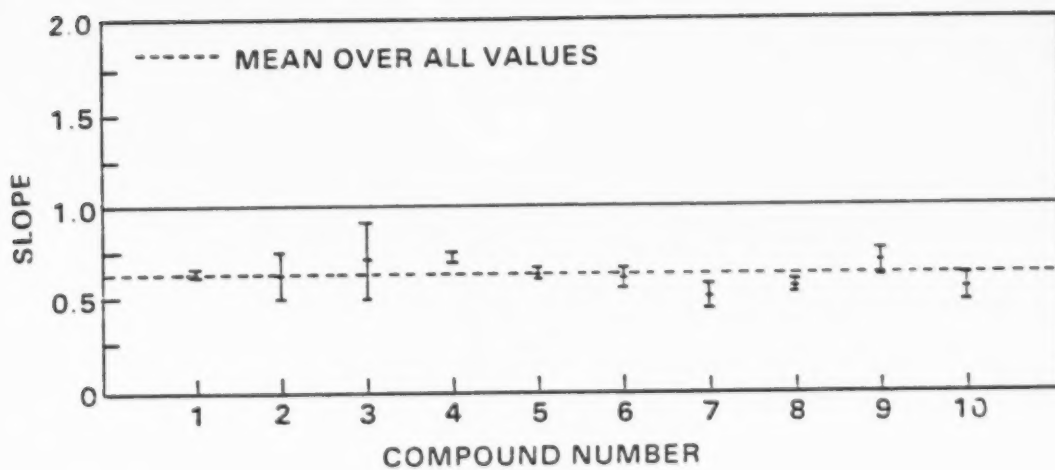


Figure 25. AGREEMENT: Tenax low rate personal sampling and canister slope plus and minus one standard error from the linear regression of Tenax mean vs canister mean.

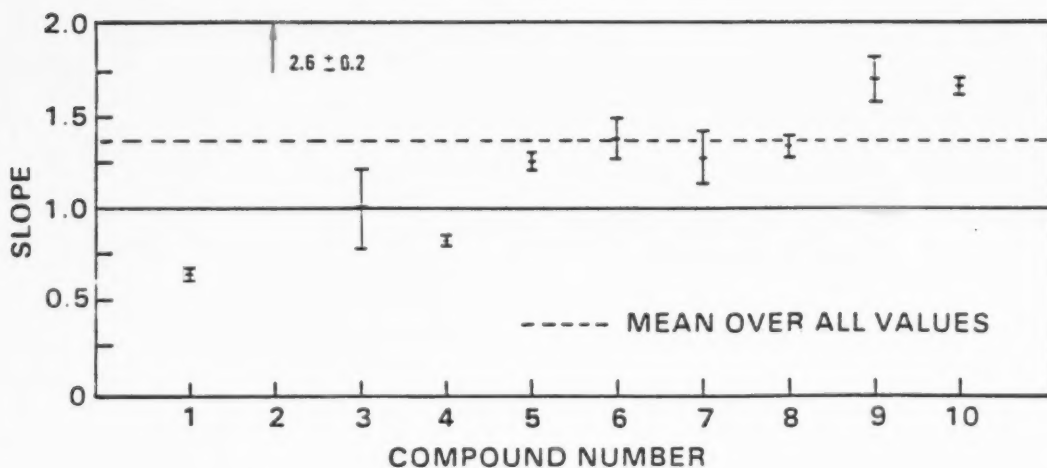


Figure 26. AGREEMENT: Tenax high rate personal sampling device and canister slope plus and minus one standard error from the linear regression of Tenax mean vs canister mean.

axis refer to the compounds as listed below; these coincide with the order of elution from the gas chromatograph.

<u>Compound No.</u>	<u>Compound</u>
1	chloroform
2	1,1,1 trichloroethane
3	benzene
4	bromodichloromethane
5	trichloroethylene
6	toluene
7	tetrachloroethylene
8	styrene
9	p-dichlorobenzene
10	hexachlorobutadiene

There are several conclusions that have been drawn from the statistical analysis, as illustrated in Figures 23-26.

1. The slope (agreement) results for DAV are shown in Figure 23. Note that + one standard error bars are drawn on the figure. In the following discussion the compound identifying numbers are shown in parenthesis.
 - a. (9) p-dichlorobenzene and (10) hexachlorobutadiene had slope estimates less than one and the estimates were within two standard errors of one.
 - b. (3) benzene, (6) toluene and (7) tetrachloroethylene had slope estimates greater than one and the estimates were within two standard errors of one.
 - c. The five other compounds had slope estimates less than one and the estimates were more than two standard errors from one.
 - d. (8) styrene was the only one of the ten compounds with an intercept estimate (0.79 ng/l) more than two standard errors from zero.
 - e. The detailed statistical analysis indicted that for the DAV Tenax, the slopes for (1) chloroform, (2) 1,1,1-trichloroethane, and (10) hexachlorobutadiene shown in Figure 23 do not adequately represent the experiment and these results should be qualified.
2. The low rate PSD slope estimates (Figure 25) show that all slope estimates were less than one and all intercept estimates were within two standard errors of zero. With the exception of (3) benzene, the slope estimates for all compounds were not within two standard errors of one. As noted earlier, the sampling rate, and therefore the sampled volume for the low rate PSDs

has an associated uncertainty of ± 25 percent. A recalibration of the sampling rates of these devices subsequent to the indoor intercomparison experiments yielded a rate which was 78 percent of the value used in this report (17). Use of this new value would improve the agreement in Figure 25.

3. The high rate PSD slope estimates (Figure 26) are as follows:
 - a. (3) benzene had a slope estimate indistinguishable from one.
 - b. (1) chloroform and (4) bromodichloromethane had slope estimates less than one but these estimates were not within two standard errors of one.
 - c. The seven remaining compounds had slope estimates greater than one and were not within two standard errors of one.
 - d. (10) hexachlorobutadiene was the only compound with an intercept estimate (-1.53 ng/l) more than two standard errors from zero.
4. The correlation between Tenax means and canister means was generally large (>0.90) for all Tenax methods. The most notable exception was (3) benzene, which had relatively small correlation coefficients for all Tenax methods.

Precision estimates were obtained for the three Tenax methods by pooling the variance of replicates over all experiments for PSD and DAV and over all nominal volumes for DAV. The precision estimate is taken as the square root of the pooled variance estimate. The compounds that showed precision estimates greater than 2.0 ng/l were:

- (3) benzene for the DAV and low rate PSD Tenax
- (6) toluene for all three Tenax methods
- (7) tetrachloroethylene for the DAV and high rate PSD Tenax
- (10) hexachlorobutadiene for the low and high rate PSD

Precision estimates for the duplicate canister sample analyses were less than 1.2 ng/l for all compounds.

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APPENDIX

STATISTICAL ANALYSIS OF DATA

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INTRODUCTION

Four Tenax methods were used in the following analyses:

1. Distributed air volume sampling with nominal sampling volumes of 5, 10, 15, and 20 liters. We will denote this method as DAV I.
2. Distributed air volume sampling with nominal sampling volumes of 5, 10, 20, and 40 liters. We will denote this method as DAV II.
3. Personal sampling devices with a low sampling rate. We will denote this method as LPSD.
4. Personal sampling devices with a high sampling rate. We will denote this method as HPSD.

Each of the four Tenax methods was compared to the canister based method on a compound by compound basis. The two distributed air volume methods were combined whenever it was appropriate.

The statistical method of analysis employed for the distributed air volume samples was taken from the analysis of covariance and the related analysis for the homogeneity of slopes. The method used for the personal sampling devices was simple linear regression. The results from analysis of the canister were selected as the reference measurements, that is, the canister results served as the independent variable. With this style of analysis, several statistics could be derived that were meaningful to the comparison of Tenax methods with the canister method.

The statistics from the various regressions that are most useful are:

1. The slope of the liner regression line. The slope indicates how well the two methods agree. If the intercept is (approximately) zero, then a slope near one shows very good agreement between the two methods.
2. The correlation coefficient for the two methods. This statistic indicates how well the two methods track one another. We would expect the two methods to show the same relative peaks and

valleys over all experiments. A correlation coefficient close to one shows that the measurements from the two methods are approximately linearly related.

3. The root mean square error from regression. This statistic indicates the scatter about the regression line. It may be used as an estimate of the precision for duplicate samples for the Tenax methods.

Several other statistics are also shown. They are:

1. A pooled estimate of the standard deviation for the Tenax and canister methods. This estimate is also an estimate of precision for the Tenax methods.
2. The y-intercept of the regression line. Since none of the regressions were forced through the origin, the intercept indicates whether or not the regression line gives a value of the Tenax method that is approximately zero when the canister method has value zero.
3. The range of concentrations in canister measurements and Tenax measurements.
4. The standard errors of slopes and intercepts. The standard errors are the appropriate 'standard deviations' for the slope- and intercept- statistics. The standard error was used to test hypotheses about the slope and intercept. For example, we tested whether or not the slope was one and the intercept zero.

The analysis for homogeneity of slope was used on the distributed air volume sets. In this case, the regression of Tenax mean on canister mean was obtained for each nominal volume. We were interested in whether or not the estimates of the slope were the same for all nominal volumes. We would expect that if the measured concentration of a compound did not depend upon nominal volume, for whatever reason, then the slopes would be the same for all nominal volumes.

If we did not detect any difference in the slopes for either distributed air volume set, we combined the data to obtain one distributed air volume set, with volumes at or near 5, 10, 15, 20, and 40 liters. For the purpose of examining the homogeneity of slopes, the design was unbalanced, that is, not all nominal volume were represented in all experiments. In this case, the test for homogeneity of slopes may not yield an exact test. The combining of the two nominal volume sets is thus used in a

descriptive sense only. Some care is necessary in the interpretation of the results.

The analysis of covariance for distributed air volume sets differs from the analysis of homogeneity of slopes in that a common regression of Tenax mean on canister mean is assumed. Thus, the analysis of homogeneity of slopes may be used to indicate when the analysis of covariance is applicable, i.e., the slopes for each nominal volume should be the same if the analysis of covariance is to be applied. The result sought in the analysis of covariance was the main effect of the nominal volume, i.e., for any differences between Tenax measurements recorded at the various nominal volumes within the distributed air volume sets. The analysis of covariance can only detect such a difference in nominal volume effects. It may or may not be useful in locating the cause of the difference.

STATISTICAL METHODS

An account of the statistical methods used in the study may be found in the standard textbooks by either Steele and Torrie (1980) or Snedecor and Cochran (1967).

The introduction stated that the main approach in this study has been regression analysis. Emphasis has been placed on examining the relationships between the various Tenax methods and the canister method. Various types of averaging were carried out before any regression was performed. In any regression analysis, the mean of the canister replicates was used as the independent variable. Since the canister means were subject to error, the slope estimates in the regressions could be biased downward. Following Snedecor and Cochran, the true slope (β') and the slope from simple linear regression (β) are related by $\beta' = (1 + \lambda)\beta$, where $\lambda \geq 0$. The value of $\hat{\lambda}$ (the estimate of λ) was calculated as

$$\hat{\lambda} = \frac{\hat{\sigma}_e^2}{(\hat{\sigma}_{x'}^2 - \hat{\sigma}_e^2)}$$

where $\hat{\sigma}_e^2 = 1/2$ (pooled variance estimate) and $\hat{\sigma}_{x'}^2$ is the sample variance of the canister means. We concluded that no correction of slope for error in the canister value was needed if $\hat{\lambda}$ was less than 0.05.

DAV Tenax

Two different experimental designs were used in considering the analyses of homogeneity of slopes and covariance. The response (Tenax) variable was obtained by taking the average of the two DAV Tenax replicates at a given nominal volume within an experiment. The independent variable was always the canister mean.

1. The first experimental design considered the nominal volume sequences to be distinct. That is, the nominal volume sequences (5, 10, 15, and 20 liters and 5, 10, 20, and 40 liters) were contained within different treatment blocks. This led to a nested design where the treatments were determined by the nominal volume sequence. Here we performed separate analyses for the experiments containing each nominal volume sequence.
2. The second design considered that the two nominal volume sequences could be combined into one nominal volume sequence (5, 10, 15, 20, and 40 liters). Nominal volumes 15 l and 40 l never appeared together in the same experiment; hence, this design is unbalanced.

In addition to the analyses above, simple linear regression was performed for DAV Tenax mean vs. canister mean. The regression was performed:

- a. By nominal volume for experiments 1-5, experiments 6-11, and experiments 1-11. In this case the dependent variable (Tenax) was the average of the two nominal volume replicates in each experiment.
- b. By ignoring nominal volumes for experiments 1-5, 6-11, and 1-11. Here the dependent variable was the average of the eight DAV Tenax values within an experiment.

The standard errors of the intercept and slope, the correlation coefficient and root mean square error, and the F-statistic for H_0 : slope=1, intercept=0 were computed from these regressions. The mean, maximum, and minimum Tenax values refer to the dependent variable used in these regressions. For the purposes of testing hypotheses about the slope and intercept separately, t-tests with N-2 d.f. were carried out.

PSD Tenax

Simple linear regression was used for the separate analyses of the high- and low-rate samplers. The dependent variable in the regression was the average of the high- or low-rate Tenax values within an experiment.

Estimates of precision for the canister and various Tenax methods were taken as the pooled standard deviation of replicates over experiments. That is, within experiments the variance of replicates was computed first. In the case of the canister, PSD Tenax, and DAV Tenax at each nominal volume, there were usually two, and sometimes three, replicates for each experiment. When the pooling was performed for all nominal volumes in the DAV Tenax, there were generally eight replicates per experiment.

The pooled standard deviation was calculated as:

$$\hat{\sigma}_p^2 = \frac{\sum_{i=1}^N d_i \hat{\sigma}_i^2}{\sum_{i=1}^N d_i}$$

where $\hat{\sigma}_i^2$ is the variance estimate in experiment i , d_i is the number of degrees of freedom used in the calculation of $\hat{\sigma}_i^2$, and N is the number of experiments over which the pooling was performed.

DATA

The data values are listed in Tables 8 through 17 in Section 3 of this report. They were analyzed intact with the exception of the following exclusions caused by suspected incomplete desorption.

1. All values in the first replicate for the high rate PSD in experiment 5.
2. The p-dichlorobenzene second replicate for the high rate PSD in experiment 5.

The decision to accept nearly all of the data led to the setting of any measurement below the indicated minimum detection level at the minimum detection level. However, the problem of very low concentrations occurred mostly in experiment 1, where background concentrations were measured.

RESULTS

The results are divided into three sections dealing with canister statistics, distributed air volume Tenax statistics, and personal sampling device Tenax statistics. They have been compiled in a series of tables and figures.

Canister Statistics

Tables IA, IB, and IC contain the mean, minimum, maximum, and pooled standard deviation estimate for the mean of canister replicates that were used in the various regressions and analyses of homogeneity of slopes and covariance. These statistics for each of the ten compounds are shown in each table.

The tables themselves contain results from sets of experiments as follows:

Table IA: experiments 1-5

Table IB: experiments 6-11

Table IC: experiments 1-11

The computed values of $\hat{\lambda}$ were as follows:

Experiments 1-5: benzene - 0.014
 hexachlorobutadiene - 0.046
 p-dichlorobenzene - 0.058
 All other compounds had values < 0.01.

Experiments 6-11: tetrachloroethylene - 0.027
 All other compounds had values < 0.01.

Experiments 1-11: All values < 0.01.

With the exception of p-dichlorobenzene for experiments 1-5, all values of $\hat{\lambda}$ were less than 0.05. This indicates that slope corrections were unnecessary, and hence, no slope corrections have been applied in the following.

Figure 1 shows the 'precision estimates' (pooled standard deviation) as given in Table IC. We note that these 'precision estimates' are lower than the corresponding Tenax 'precision estimates'. One reason for this

is that the canister replicates were taken from the same can. Hence, we are estimating analytical 'precision'. The Tenax replicates were obtained from independent sample sets and the 'precision estimates' represent the combined sampling and analytical 'precision'.

Distributed Air Volume Tenax Statistics

The DAV Tenax results are collected in Tables IIA-C, IIIA-C and IVA-C. The tables are arranged as follows:

Tables IIA-C: experiments 1-5

Tables IIIA-C: experiments 6-11

Tables IVA-C: experiments 1-11

The 'A' tables contain the following statistics:

1. Number of experiments to which the statistics apply (N).
2. Slope of the Tenax vs. canister regression line.
3. Standard error of the slope.
4. Intercept of the Tenax vs. canister regression line.
5. Standard error of the intercept.
6. F-statistic for the hypothesis: slope=1, intercept=0.
7. Correlation coefficient between Tenax means and canister means.

The 'B' tables contain the following statistics:

1. Number of experiments to which the statistics apply (N).
2. Root mean square error from the Tenax vs. canister regression.
3. Pooled standard deviation estimate.
4. F-statistic for the hypothesis: slopes are homogeneous.
5. F-statistic for the hypothesis: no nominal volume main effect.
6. Mean, minimum, and maximum of the Tenax means for the experiments in question.

In the 'B' tables we have listed the F-statistics for (4) and (5) on the line, '6) Tenax - All Nominal Volumes'.

The numbers of degrees of freedom and F-values for $p=.01$ and $p=.05$ needed to interpret the various F-statistics are listed at the bottom of each table. For the sake of clarity we give the appropriate number of degrees of freedom (numerator/denominator) for each hypothesis.

H_0 : slope=1, intercept=0 (3/N-2)

H_0 : slope homogeneous and H_0 : no nominal volume main effects

(3/12) in Tables IB and IIB

(3/32) in Table IIB

The 'C' tables give the results of the tests of significance concerning the slopes, intercepts, heterogeneity of slopes, and nominal volume main effects. Results for the following tests of significance (H_0 and H_A are the null and alternative hypothesis, respectively) are given in the corresponding column:

H_0 : slope = 1; intercept = 0; H_A : slope $\neq$ or intercept $\neq$ or both
in column 'Alpha, Beta'

H_0 : intercept = 0; H_A : intercept $\neq$ 0 in column 'Alpha'

H_0 : slope = 1; H_A : slope $\neq$ 1 in column 'Beta'

H_0 : slope = 0; H_A : slope $\neq$ 0 in column 'Beta'

H_0 : slopes homogeneous; H_A : at least one slope different from
others in column 'Homogeneity'

H_0 : no nominal volume main effect; H_A : at least one nominal
volume effect different from others in column 'Nominal Volume'

The notations in the body of the tables give the results of the tests of significance listed above. The notations for all tests of hypotheses, except H_0 : slope = 0 are:

- no symbol: insufficient evidence to reject the null hypothesis at the 0.05 level of significance.
- * : the null hypothesis is rejected at the 0.05 level of significance but not the 0.01 level of significance
- ** : the null hypothesis is rejected at the 0.01 level of significance.

For the hypothesis test H_0 : slope = 0 in column 'Beta', the notations are:

- no symbol: reject the null hypothesis at the 0.01 level of significance (or * or **)
- 00 : insufficient evidence to reject the null hypothesis at the 0.05 level of significance.
- 0 : insufficient evidence to reject the null hypothesis at the 0.01 level of significance, but the null hypothesis is rejected at the 0.05 level of significance.

The notations also are described at the bottom of each 'C' Table.
The figures below summarize some of the DAV Tenax results:

- Figure 2: Precision: pooled standard deviation
- Figure 3: Agreement: slope of the Tenax mean vs. canister mean regression.
- Figure 4: Correlation: correlation coefficient of the Tenax mean and canister mean.
- Figure 5: Scatter: root mean square error from the Tenax mean vs. canister mean regression.

The numbers used to draw the figures are found in Tables IVA and IVB on the line, '6) Tenax - All Volumes'. These statistics represent an overall summary of the DAV Tenax statistics.

Passive Sampling Device Tenax Statistics

The tables and figures for the passive sampling device Tenax are similar to the DAV Tenax tables.

Tables VA-C: low sampling rate, experiments 1-11.

Tables VIA-C: high sampling rate, experiments 1-11.

The 'A' tables are arranged exactly as for the DAV Tenax results. The 'B' tables do not contain any F-statistics. That is, nominal volume series are not present for the PSD Tenax.

Figures 6-9: precision, agreement, correlation, and scatter, respectively, for the high sampling rate.

Figures 10-13: precision, agreement, correlation, and scatter, respectively, for the high sampling rate.

All figures presented here have a 'compound number' plotted on the horizontal axis. The order of the compounds on the axis is from least to greatest retention time (left to right). The correspondence between compound number and compound is:

1. chloroform
2. 1,1,1-trichloroethane
3. benzene
4. bromodichloromethane
5. trichloroethylene
6. toluene
7. tetrachloroethylene
8. styrene
9. p-dichlorobenzene
10. hexachlorobutadiene

DISCUSSION

The statistical assessment of how well the Tenax-based and canister-based measurement systems agreed in terms of measured concentration rests

in large part upon the interpretation of three statistics derived in the simple linear regression of Tenax means vs. canister means. The statistics are the slope and intercept for the regression and the correlation coefficient between the canister and Tenax measured concentrations. If the agreement between the methods was exact, then we would expect the regression line to have a slope of one and an intercept of zero. In addition, the correlation coefficient between the Tenax and canister measured concentrations would be one.

The assessment of the agreement was carried out via the F-statistics compiled in the course of analysis. The F-statistics themselves or the results of tests of hypotheses using the F-statistics are displayed in the tables. The interpretation we have followed is that the F-statistic is: (1) significant if $F > F_{.01}$; (2) slightly significant if $F_{.05} \leq F \leq F_{.01}$; and (3) not significant if $F < F_{.05}$. This interpretation is given in place of listing the level of significance for each compiled F-statistic.

The results of the tests of hypotheses shown in the 'C' tables for the DAV and PSD Tenax based methods present a good overall summary of the canister-Tenax comparisons that were made. The best result, in terms of agreement, would be that the 'C' tables have no entry in any cell for any compound. Departures from 'ideal' agreement are seen whenever a cell in a 'C' table contains an entry. In addition to the 'C' table results, the correlation coefficient should be close to one.

A closer reading of the 'C' tables should be done in the following manner. First, the 'Alpha, Beta' column for the null hypothesis: slope = 1, intercept = 0 is examined. If any entry appears in a cell, then we infer that the slope is not 'close' to one or the intercept is not 'close' to 0 or both. Next, the 'Alpha' (H_0 : intercept = 0) and 'Beta' (H_0 : slope = 1) columns may be used to indicate whether the slope or intercept may be accounting for a departure from the ideal behavior. A further complication with the slope can arise if the null hypothesis: slope = 0 cannot be rejected. This indicates that the canister values are not very good predictors of the Tenax values. This problem is likely to arise when the standard error of the slope is 'large'.

The four slope estimates derived from the DAV Tenax should be the same for a given compound within an experiment. That is, each of the four Tenax methods should ideally give the same resultant concentration

at each nominal volume. A constant slope not equal to one across nominal volumes or a series of slopes that increase or decrease with nominal volume may be suggestive of a systematic cause for the discrepancy between the canister based and Tenax based methods. However, the statistics may not be very suggestive of where the cause lies.

The statistics shown in the canister tables and the Tenax 'B' tables, aside from the F-statistics, are essentially descriptive in nature. The mean, minimum, and maximum values give an idea of the range of concentrations encountered in the regressions that were done. The two 'precision estimates', namely, root mean square error and pooled standard deviation, are interpreted as estimates of the error arising from the sampling and analytical measurement errors, combined. We would expect the two 'precision estimates' to be in fairly good agreement, even though they are derived in very different ways.

DAV Tenax Means and Canister Means

An interesting question that we may ask about the DAV data sets is whether or not the estimates are the same for every nominal volume. Alternatively, we may examine the fraction of the true concentration to see if it is constant for all nominal volumes. As explained above, we have followed the latter course for the Battelle study. We derived separate estimates of the slope in the DAV Tenax means on the canister means regression and we examined how homogeneous the slopes were. If no difference was detected among the slopes, we felt confident that all of the DAV Tenax data for a compound could be combined to make a single estimate of the DAV Tenax mean vs. canister mean slope.

The Battelle data introduced a complication in that two different nominal volume series were used during the course of the experiment. Thus, three separate analyses for the homogeneity of slopes across nominal volumes were carried out:

1. DAV I as the (5, 10, 15, and 20 liters) nominal volume series (Table II).
2. DAV II as the (5, 10, 20, and 40 liter:) nominal volume series (Table III).
3. DAV III as the (5, 10, 15, 20, and 40 liters) nominal volume series (Table IV).

DAV III was derived by combining DAV I and DAV II. As noted above, the 'A' tables contain the slope and correlation coefficient estimates. The 'B' tables have the F-statistics for the tests of the homogeneity of slopes and nominal volume main effects. The 'C' tables contain summaries of tests of significance about the slopes and intercepts.

With respect to 'ideal' agreement between the canister and Tenax based methods, the 'C' tables reveal a wide range of behavior from no departure to very large departures from 'ideal' agreement. The specific results are as follow:

1. The DAV I set did not show any heterogeneity of slopes for any compound. That is, $F < F_{.05}$ in the test for homogeneity of slopes across nominal volumes.

The three compounds 1,1,1-trichloroethane, trichloroethylene, and toluene show no entry in Table IIC. Also, the correlation coefficient between the canister based and Tenax based methods is > 0.98 in all cases.

The three compounds bromodichloromethane, styrene, and tetrachloroethylene have entries in the 'Alpha, Beta' column for various nominal volumes. Only in the case of 15-liter tetrachloroethylene is the departure directly attributable to the slope estimate (> 1). In all cases, the correlation coefficient is > 0.98 .

The three compounds benzene, p-dichlorobenzene, and hexachlorobutadiene did not show a slope estimate significantly different from zero (or one). The cause of this behavior is that a relatively large proportion of the data had variation not explained by the linear regression. Correlation coefficients for benzene are less than 0.76 and for hexachlorobutadiene less than 0.70. p-dichlorobenzene might be considered to depart less significantly from ideal agreement.

Chloroform showed the most marked deviation from ideal agreement. Although correlation coefficients were large (> 0.99), the slope estimates all were less than one, except for the 25L case.

2. The DAV II set showed different patterns of deviation from ideal agreement than the DAV I set.

Benzene and p-dichlorobenzene results indicated no departures from ideal agreement. Correlation coefficients were greater than 0.96.

Toluene and styrene had slight departures from ideal agreement with correlation coefficients greater than 0.95. In both cases, the null hypothesis H_0 : slope = 1, intercept = 0, was not rejected at the 0.01 significance level for any compound.

Tetrachloroethylene did not show a slope estimate significantly different from zero for any nominal volume. All correlation coefficients were less than 0.88.

The two compounds bromodichloromethane and trichloroethylene had entries in the 'Alpha, Beta' column of Table 'C'. Where an entry occurred in the 'Alpha, Beta' column, the departure from ideal agreement is attributable to a slope significantly less than one in all cases. Correlation coefficients all were greater than 0.99.

The three compounds chloroform, 1,1,1-trichloroethane and hexachlorobutadiene all showed evidence of heterogeneity of slopes. In the cases of chloroform and 1,1,1-trichloroethane the slope estimates generally decrease with increasing nominal volume. The hexachlorobutadiene slope series increases with nominal volume. In all cases, slope estimates were less than or equal to one.

3. The DAV III set is the combined DAV I and DAV II sets. In Table IVC, the nominal volume columns for 15 l and 40 l are the same as for those columns in Table IIC and Table IIIC, respectively. Note that in Table IVC, every line has at least one cell filled. That is, every compound shows some departure from ideal agreement when all the DAV Tenax data is combined.

Benzene and p-dichlorobenzene show nearly ideal agreement. The only exception is in the 25 l entry of the 'Beta' column.

The remaining eight compounds have table entries in the 'Alpha, Beta' column. The departures from ideal behavior are explained by slopes significantly less than one in the cases of bromodichloromethane, trichloroethylene, and hexachlorobutadiene. The styrene departures are generally accounted for by intercept estimates significantly greater than zero. For toluene and tetrachloroethylene, departures from ideal behavior are not accounted for by either the slope or intercept in all cases.

As in the case of DAV II, chloroform and 1,1,1-trichloroethane show strong evidence that the slope estimates are heterogeneous across nominal volumes.

With the exceptions of benzene (15 l), tetrachloroethylene (40 l) and hexachlorobutadiene (15 l), correlation coefficients are all greater than 0.90.

The results for the three DAV series are diverse and no general assessment of how well the canister-based and Tenax-based methods agree is readily apparent. An overall summary of the point estimates of precision, agreement, correlation, and scatter is shown in Figures 2-5. Based on the DAV Tenax results, the following points are pertinent:

1. For chloroform and 1,1,1-trichloroethane, pooling of results is not supported from the analysis of heterogeneity of slopes. That is, the points for compound numbers (1) and (2) in the figures should be disregarded as they are not representative of the entire experiment. The results for these two compounds should be considered on a nominal value basis.
2. Styrene shows a significant positive intercept. Hence, in Figure 3, the point for compound number 8 is not representative of the agreement over the whole experiment.
3. The data for the figures for the remaining compounds presents an adequate summary of the experimental results.

The conclusions for compounds 3-10 are as follow:

1. The two compounds (4) bromodichloromethane and (5) trichloroethylene show evidence that the slope estimates are less than one. The remaining compounds do not yield slope estimates significantly different from one. In all cases except styrene the intercept estimate is not different from 0.
2. Correlation between the canister-based and Tenax-based methods is large. The estimates exceed 0.93 in all cases.
3. Precision and scatter estimates are in fairly good agreement. The ratio pooled standard deviation/RMSE ranges from 0.75 to 1.88.

PSD Tenax Means and Canister Means

The PSD means for low and high sampling rates were compared to the canister means via simple linear regression on a compound-by-compound basis.

Low Rate PSD

1. Table VC has an entry for every compound in the 'Alpha Beta' column. In all cases except benzene, this may be attributed to a slope significantly less than one. We inferred that with the exception of benzene the low rate PSD undersampled relative to the canister mean.

2. The correlation coefficients all were ≥ 0.90 , with the exception of benzene. This indicated that the tracking of the canister means by the low rate PSD means was very good.
3. The precision and scatter estimates were in fairly good agreement with the ratio pooled standard deviation/RMSE ranging between 0.39 and 2.07.

High Rate PSD

1. All compounds, excepting benzene, had an entry in the 'Alpha, Beta' column in Table VIC. The slope accounts for the departure from agreement, excepting tetrachloroethylene and hexachlorobutadiene. Chloroform and bromodichloromethane had slope estimates less than one. Benzene showed a slope estimate not different from one. The remaining compounds had slope estimates greater than one. The slope estimate for 1,1,1-trichloroethane is so large that it may be spurious.
2. The correlation coefficients were all greater than 0.95, with the exception of benzene.
3. The precision and scatter estimates were generally in worse agreement than for the low rate PSD. The PSD/RMSE ratio ranged between 0.12 and 2.14.

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TABLE 1A
CANISTER STATISTICS: EXPERIMENTS 1-5

Compound		Pooled Standard Deviation (ng/l)	Mean of the Canister Values (ng/l)	Minimum of the Canister Values (ng/l)	Maximum of the Canister Values (ng/l)
Benzene	5	0.524	12.205	9.426	17.561
Bromodichloromethane	5	0.162	2.910	0.328	5.533
Chloroform	5	0.329	4.631	0.328	9.098
Hexachlorobutadiene	5	0.230	2.262	1.393	3.033
p-Dichlorobenzene	5	0.664	4.002	1.148	6.230
Styrene	5	0.192	2.336	0.164	4.262
Tetrachloroethylene	5	1.454	24.533	12.746	45.574
Toluene	5	1.236	24.270	8.648	49.344
Trichloroethylene	5	0.272	3.082	0.492	5.820
1,1,1-Trichloroethane	5	0.407	6.508	2.541	11.393

TABLE IB
CANISTER STATISTICS: EXPERIMENTS 6-11

Compound	N	Pooled Standard Deviation	Mean of the Canister Values	Minimum of the Canister Values	Maximum of the Canister Values
		(ng/l)	(ng/l)	(ng/l)	(ng/l)
Benzene	5	0.537	15.369	6.189	27.131
Bromodichloromethane	5	0.087	7.992	0.369	18.115
Chloroform	5	0.339	11.680	1.393	25.410
Hexachlorobutadiene	5	0.539	9.672	1.393	22.418
P-Dichlorobenzene	5	0.194	7.533	3.074	14.344
Styrene	5	0.186	6.664	0.656	16.025
Tetrachloroethylene	5	0.705	34.041	29.918	37.828
Toluene	5	0.507	24.049	7.295	32.992
Trichloroethylene	5	0.123	8.262	0.533	18.566
1,1,1-Trichloroethane	5	0.609	12.238	3.443	22.254

TABLE IC
CANISTER STATISTICS: EXPERIMENTS 1-11

Compound	N	Pooled Standard Deviation	Mean of the Canister Values	Minimum of the Canister Values	Maximum of the Canister Values
		(ng/l)	(ng/l)	(ng/l)	(ng/l)
Benzene	10	0.530	13.797	6.189	27.131
Bromodichloromethane	10	0.134	5.451	0.328	18.115
Chloroform	10	0.334	8.156	0.328	25.410
Hexachlorobutadiene	10	0.401	5.967	1.393	22.418
p-Dichlorobenzene	10	0.512	5.807	1.148	14.344
Styrene	10	0.189	4.500	0.164	16.025
Tetrachloroethylene	10	1.181	29.287	12.746	45.574
Toluene	10	0.981	24.160	7.295	49.344
Trichloroethylene	10	0.219	5.672	0.492	18.566
1,1,1-Trichloroethane	10	0.506	9.373	2.541	22.254

TABLE IIA
Tenax Distributed Air Volume System: Experiments 1-5
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Slope	Standard Error of the Slope	Intercept		Standard Error of the Intercept	F Statistic: Slope=1, Intercept=0	Correlation Between Tenax and Canister
					(ng/L)	(ng/L)			
Benzene	1) Tenax - 5L	5	1.333	0.672	-5.754		6.422	0.5202	0.753
	2) Tenax - 10L	5	1.343	0.611	-6.148		7.654	0.8115	0.785
	3) Tenax - 15L	5	1.282	0.705	-4.991		8.832	0.3838	0.724
	4) Tenax - 20L	5	1.182	0.621	-4.432		7.774	0.8486	0.740
	6) Tenax - All Volumes	5	1.285	0.647	-5.331		8.101	0.6161	0.754
Bromodichloromethane	Experiment Type								
	1) Tenax - 5L	5	0.828	0.065	0.050		0.227	9.8871	0.991
	2) Tenax - 10L	5	0.899	0.064	0.044		0.224	3.2762	0.992
	3) Tenax - 15L	5	0.915	0.062	0.027		0.217	2.6214	0.993
	4) Tenax - 20L	5	0.934	0.043	0.002		0.169	3.0024	0.996
	6) Tenax - All Volumes	5	0.894	0.057	0.031		0.199	4.9036	0.994
Chloroform	Experiment Type								
	1) Tenax - 5L	5	0.816	0.036	0.099		0.202	34.9379	0.997
	2) Tenax - 10L	5	0.784	0.041	0.250		0.227	31.4504	0.996
	3) Tenax - 15L	5	0.893	0.050	0.036		0.278	6.6587	0.995
	4) Tenax - 20L	5	0.814	0.029	0.119		0.164	52.4843	0.998
	6) Tenax - All Volumes	5	0.827	0.030	0.126		0.167	42.9471	0.998

(CONTINUED)

F values with 2 numerator and 3 denominator df
p=0.01, F=30.82; p=0.05, F=9.55

TABLE IIA
Tenax Distributed Air Volume System: Experiments 1-5
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Slope	Standard Error of the Slope	Intercept		Standard Error of the Intercept	F Statistic: Slope=1, Intercept=0	Correlation Between Tenax and Canister
					(ng/L)	(ng/L)			
Hexachlorobutadiene	1) Tenax - 5L	5	0.921	0.729	-0.464	1.731	0.7591	0.589	
	2) Tenax - 10L	5	1.638	0.972	-1.326	2.308	0.2297	0.697	
	3) Tenax - 15L	5	1.857	1.133	-1.582	2.690	0.3629	0.687	
	4) Tenax - 20L	5	0.363	0.793	0.750	1.883	1.0626	0.255	
	6) Tenax - All Volumes	5	1.195	0.725	-0.656	1.720	0.1215	0.689	
	Experiment Type								
P-Dichlorobenzene	1) Tenax - 5L	5	1.105	0.143	0.011	0.639	1.7280	0.976	
	2) Tenax - 10L	5	0.997	0.295	0.310	1.315	0.1598	0.890	
	3) Tenax - 15L	5	1.310	0.282	-1.130	1.255	0.6385	0.937	
	4) Tenax - 20L	5	0.991	0.189	-0.297	0.843	0.4833	0.950	
	6) Tenax - All Volumes	5	1.101	0.202	-0.279	0.901	0.1920	0.953	
	Experiment Type								
Styrene	1) Tenax - 5L	5	1.196	0.099	0.265	0.279	12.8665	0.990	
	2) Tenax - 10L	5	1.073	0.073	0.473	0.219	14.4996	0.992	
	3) Tenax - 15L	5	1.181	0.104	0.270	0.292	10.6674	0.989	
	4) Tenax - 20L	5	1.065	0.085	0.311	0.239	6.4048	0.991	
	6) Tenax - All Volumes	5	1.129	0.083	0.330	0.232	13.1754	0.992	
	Experiment Type								

(CONTINUED)

F values with 2 numerator and 3 denominator df
p=0.01, F=30.82; p=0.05, F=9.55

TABLE IIA
Tenax Distributed Air Volume System: Experiments 1-5
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Slope	Standard Error of the Slope	Intercept		Standard Error of the Intercept	F Statistic: Slope=1, Intercept=0	Correlation Between Tenax and Canister
					(ng/L)	(ng/L)			
Tetrachloro-ethylene	1) Tenax - 5L	5	1.177	0.098	-1.320		2.731	4.3553	0.990
	2) Tenax - 10L	5	1.065	0.095	0.341		2.640	1.4404	0.988
	3) Tenax - 15L	5	1.205	0.054	-1.871		1.514	16.9292	0.997
	4) Tenax - 20L	5	1.153	0.067	-0.648		1.867	8.8020	0.995
	6) Tenax - All Volumes	5	1.150	0.056	-0.875		1.551	10.9590	0.996
	Experiment Type								
Toluene	1) Tenax - 5L	5	1.093	0.103	1.002		2.858	3.1480	0.987
	2) Tenax - 10L	5	1.040	0.088	1.514		2.450	2.2745	0.989
	3) Tenax - 15L	5	1.002	0.075	2.546		2.092	3.2498	0.992
	4) Tenax - 20L	5	0.878	0.075	4.421		2.079	2.3781	0.989
	6) Tenax - All Volumes	5	1.003	0.080	2.371		2.210	2.6012	0.991
	Experiment Type								
Trichloro-ethylene	1) Tenax - 5L	5	1.060	0.089	-0.418		0.327	1.0761	0.990
	2) Tenax - 10L	5	1.017	0.068	-0.266		0.252	1.4534	0.993
	3) Tenax - 15L	5	1.109	0.079	-0.419		0.291	1.0853	0.992
	4) Tenax - 20L	5	0.994	0.052	-0.295		0.192	4.4186	0.996
	6) Tenax - All Volumes	5	1.045	0.055	-0.354		0.202	2.2336	0.996
	Experiment Type								

(CONTINUED)

F values with 2 numerator and 3 denominator df
p=0.01, F=30.82; p=0.05, F=9.55

TABLE IIA
Tenax Distributed Air Volume System: Experiments 1-5
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Slope	Standard Error of the Slope	Intercept		Standard Error of the Intercept	F Statistic: Slope=1, Intercept=0	Correlation Between Tenax and Canister
					(ng/L)	(ng/L)			
1,1,1-Trichloroethane	1) Tenax - 5L	5	0.879	0.093	0.110		0.669	3.6281	0.984
	2) Tenax - 10L	5	0.855	0.070	0.453		0.507	4.6241	0.990
	3) Tenax - 15L	5	0.892	0.087	0.396		0.627	1.4290	0.986
	4) Tenax - 20L	5	0.848	0.073	0.509		0.530	4.3354	0.989
	6) Tenax - All Volumes	5	0.869	0.074	0.367		0.533	3.8506	0.989

TABLE IIB
Tenax Distributed Air Volume System: Experiments 1-5
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Root Mean Square Error From Regression		Pooled Standard Deviation	F Statistic: Slopes Homogeneous	F Statistic: Nominal Volume Effect	Mean of the Tenax Values (ng/l)	Minimum of the Tenax Values (ng/l)	Maximum of the Tenax Values (ng/l)
			(ng/l)	(ng/l)						
Benzene	1) Tenax - 5L	5	4.227		1.034			10.520	2.350	17.650
	2) Tenax - 10L	5	3.841		1.054			10.240	2.650	17.700
	3) Tenax - 15L	5	4.432		0.910			10.660	2.350	17.500
	4) Tenax - 20L	5	3.901		0.288			9.990	2.550	16.600
	6) Tenax - All Volumes	5	4.066		0.879	0.0100	0.0300	10.352	2.350	17.700
Bromodichloroethane	1) Tenax - 5L	5	0.281		0.303			2.460	0.100	4.750
	2) Tenax - 10L	5	0.277		0.195			2.660	0.100	5.050
	3) Tenax - 15L	5	0.268		0.336			2.690	0.100	5.100
	4) Tenax - 20L	5	0.208		0.148			2.720	0.150	5.100
	6) Tenax - All Volumes	5	0.246		0.257	0.5900	1.1100	2.632	0.100	5.100
Chloroform	1) Tenax - 5L	5	0.254		0.405			3.880	0.350	7.750
	2) Tenax - 10L	5	0.286		0.313			3.880	0.500	7.650
	3) Tenax - 15L	5	0.350		0.251			4.170	0.300	8.150
	4) Tenax - 20L	5	0.206		0.071			3.890	0.350	7.450
	6) Tenax - All Volumes	5	0.210		0.287	1.3700	1.2300	3.955	0.300	8.150

(CONTINUED)

F values with 3 numerator and 12 denominator df
p=0.01, F=5.95; p=0.05, F=3.49

TABLE IIB
Tenax Distributed Air Volume System: Experiments 1-5
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Root Mean Square Error From Regression (ng/l)	Pooled Standard Deviation (ng/l)	F Statistic: Slopes Homogeneous	F Statistic: Nominal Volume Effect	Mean of the Tenax Values (ng/l)	Minimum of the Tenax Values (ng/l)	Maximum of the Tenax Values (ng/l)
Hexachloro- butadiene	1) Tenax - 5L	5	1.170	0.214			1.620	0.950	3.850
	2) Tenax - 10L	5	1.560	0.427			2.380	1.000	4.950
	3) Tenax - 15L	5	1.819	0.952			2.620	1.000	5.650
	4) Tenax - 20L	5	1.273	0.192			1.570	1.000	3.600
	6) Tenax - All Volumes	5	1.163	0.541	0.5500	0.7100	2.047	0.950	5.650
P-Dichloro- benzene	1) Tenax - 5L	5	0.573	0.567			4.520	1.350	7.100
	2) Tenax - 10L	5	1.179	0.794			4.380	1.950	6.800
	3) Tenax - 15L	5	1.126	0.446			4.210	0.450	7.050
	4) Tenax - 20L	5	0.756	0.239			3.750	0.700	6.350
	6) Tenax - All Volumes	5	0.808	0.550	0.4000	0.7200	4.215	0.450	7.100
Styrene	1) Tenax - 5L	5	0.347	0.290			3.060	0.450	5.650
	2) Tenax - 10L	5	0.272	0.205			2.980	0.650	5.000
	3) Tenax - 15L	5	0.363	0.243			3.030	0.450	5.200
	4) Tenax - 20L	5	0.297	0.110			2.800	0.550	4.850
	6) Tenax - All Volumes	5	0.289	0.222	0.5700	0.7200	2.967	0.450	5.650

(CONTINUED)

F values with 3 numerator and 12 denominator df
p=0.01, F=5.95; p=0.05, F=3.49

TABLE IIB
Tenax Distributed Air Volume System: Experiments 1-5
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Root Mean Square Error From Regression		Pooled Standard Deviation	F Statistic: Slopes Homogeneous	F Statistic: Nominal Volume Effect	Mean of the Tenax Values		Minimum of the Tenax Values		Maximum of the Tenax Values	
			(ng/l)	(ng/l)				(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)
Tetrachloro-ethylene	1) Tenax - 5L	5	2.866		3.998			27.550		11.750		50.000	
	2) Tenax - 10L	5	2.790		4.397			26.470		12.000		50.550	
	3) Tenax - 15L	5	1.600		2.070			27.700		12.300		53.150	
	4) Tenax - 20L	5	1.973		0.903			27.640		11.850		52.050	
	6) Tenax - All Volumes	5	1.639		3.179	0.5600	0.3300	27.340		11.750		53.150	
	Experiment Type												
Toluene	1) Tenax - 5L	5	3.102		2.224			27.520		8.600		54.500	
	2) Tenax - 10L	5	2.660		3.142			26.750		10.050		53.000	
	3) Tenax - 15L	5	2.271		2.615			26.860		8.900		51.150	
	4) Tenax - 20L	5	2.257		0.792			25.740		9.850		47.000	
	6) Tenax - All Volumes	5	2.399		2.360	1.1200	0.3900	26.717		8.600		54.500	
	Experiment Type												
Trichloro-ethylene	1) Tenax - 5L	5	0.399		0.288			2.850		0.150		6.150	
	2) Tenax - 10L	5	0.308		0.217			2.850		0.200		5.800	
	3) Tenax - 15L	5	0.356		0.326			3.000		0.150		5.800	
	4) Tenax - 20L	5	0.235		0.138			2.770		0.150		5.500	
	6) Tenax - All Volumes	5	0.247		0.252	0.4700	0.4700	2.867		0.150		6.150	
	Experiment Type												

(CONTINUED)

F values with 3 numerator and 12 denominator df
p=0.01, F=5.95; p=0.05, F=3.49

TABLE IIB
Tenax Distributed Air Volume System: Experiments 1-5
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Root Mean Square Error From Regression		Pooled Standard Deviation	F Statistic: Slopes Homogeneous	F Statistic: Nominal Volume Effect	Mean of the Tenax Values (ng/l)	Minimum of the Tenax Values (ng/l)	Maximum of the Tenax Values (ng/l)
			(ng/l)	(ng/l)						
1,1,1-Trichloroethane	1) Tenax - 5L	5	0.643		0.470			5.830	1.600	9.800
	2) Tenax - 10L	5	0.487		0.691			6.020	2.250	9.900
	3) Tenax - 15L	5	0.602		0.454			6.200	2.300	10.100
	4) Tenax - 20L	5	0.509		0.138			6.030	2.450	9.800
	6) Tenax - All Volumes	5	0.512		0.461	0.0600	0.4400	6.020	1.600	10.100

F values with 3 numerator and 12 denominator df
p=0.01, F=5.95; p=0.05, F=3.49

TABLE IIC
Tenax Distributed Air Volume System: Experiments 1-5
Summary of Tests of Significance for the Slope and Intercept
From the Regression Analysis of Tenax Means on Canister Means

Compound	Alpha, Beta		Alpha		Beta		Heterogeneity of Slopes	Nominal Volume
	Nominal Volume	5 10 15 20 All	Nominal Volume	5 10 15 20 All	Nominal Volume	5 10 15 20 All		
Benzene								
Bromodichloromethane	*							
Chloroform	**	**			*	*		
Hexachlorobutadiene								
P-Dichlorobenzene					0	0	0	0
Styrene	*	*	*	*				
Tetrachloroethylene		*	*	*	*	*		
Toluene								
Trichloroethylene								
1,1,1-Trichloroethane								

*: Null hypothesis rejected at the 0.05 significance level
and not rejected at the 0.01 significance level.
**: Null hypothesis rejected at the 0.01 significance level.
00: Null hypothesis: Slope=0 not rejected at the 0.05 significance level.
0: Null hypothesis: Slope=0 rejected at the 0.05 significance level
and not rejected at the 0.01 significance level

TABLE IIIA
Tenax Distributed Air Volume System: Experiments 6-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Slope	Standard Error of the Slope	Intercept (ng/L)	Standard Error of the Intercept (ng/L)	F Statistic: Slope=1, Intercept=0	Correlation Between Tenax and Canister
Benzene	1) Tenax - 5L	5	0.904	0.134	0.603	2.332	0.5675	0.969
	2) Tenax - 10L	5	1.052	0.163	-1.666	2.838	0.2610	0.966
	4) Tenax - 20L	5	1.062	0.138	-1.252	2.398	0.1365	0.976
	5) Tenax - 40L	5	1.130	0.136	-2.819	2.374	0.7241	0.979
	6) Tenax - All Volumes	5	1.037	0.101	-1.204	1.754	0.4396	0.986
	Experiment Type							
Bromodichloromethane	1) Tenax - 5L	5	0.897	0.046	0.601	0.501	2.7315	0.996
	2) Tenax - 10L	5	0.829	0.031	0.528	0.342	21.5116	0.998
	4) Tenax - 20L	5	0.833	0.045	0.399	0.490	10.7828	0.996
	5) Tenax - 40L	5	0.841	0.023	0.238	0.255	40.7056	0.999
	6) Tenax - All Volumes	5	0.850	0.026	0.441	0.286	23.9237	0.999
	Experiment Type							
Chloroform	1) Tenax - 5L	5	0.986	0.108	1.099	1.698	0.3496	0.982
	2) Tenax - 10L	5	0.915	0.078	0.735	1.232	0.6407	0.989
	4) Tenax - 20L	5	0.801	0.050	0.410	0.791	14.2950	0.994
	5) Tenax - 40L	5	0.480	0.022	-0.368	0.347	662.4583	0.997
	6) Tenax - All Volumes	5	0.796	0.058	0.464	0.919	11.0055	0.992
	Experiment Type							

F values with 2 numerator and 3 denominator df
p=0.01, F=10.82; p=0.05, F=9.55

(CONTINUED)

TABLE VIII
Tenax Distributed Air Volume System: Experiments 6-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound		Experiment Type	N	Slope	Standard Error of the Slope	Intercept		Standard Error of the Intercept (ng/L)	F Statistic: Slope=1, Intercept=0	Correlation Between Tenax and Canister
						(ng/L)	(ng/L)			
Hexachlorobutadiene										
	1) Tenax - 5L	5	0.906	0.033	-0.267		0.423	12.7568	0.998	
	2) Tenax - 10L	5	0.958	0.036	-0.354		0.467	3.6683	0.998	
	4) Tenax - 20L	5	0.975	0.027	-0.211		0.347	2.3298	0.999	
	5) Tenax - 40L	5	1.045	0.016	-0.117		0.208	6.5895	1.000	
	6) Tenax - All Volumes	5	0.971	0.015	-0.237		0.200	9.2811	1.000	
p-Dichlorobenzene										
	1) Tenax - 5L	5	1.016	0.068	0.424		0.603	1.5706	0.993	
	2) Tenax - 10L	5	0.951	0.054	0.469		0.476	0.4959	0.995	
	4) Tenax - 20L	5	0.936	0.048	0.676		0.422	1.2856	0.996	
	5) Tenax - 40L	5	0.957	0.031	0.390		0.272	1.0727	0.998	
	6) Tenax - All Volumes	5	0.965	0.036	0.490		0.314	1.4575	0.998	
Styrene										
	1) Tenax - 5L	5	0.942	0.086	0.951		0.769	0.8294	0.988	
	2) Tenax - 10L	5	0.916	0.062	0.797		0.558	1.1187	0.993	
	4) Tenax - 20L	5	0.908	0.026	0.848		0.231	7.5775	0.999	
	5) Tenax - 40L	5	0.899	0.058	0.797		0.517	1.5958	0.994	
	6) Tenax - All Volumes	5	0.916	0.056	0.851		0.504	1.4915	0.994	

(CONTINUED)

F values with 2 numerator and 3 denominator df
p=0.01, F=30.82; p=0.05, F=9.55

TABLE IIIA
Tenax Distributed Air Volume System: Experiments 6-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Slope	Standard Error of the Slope	Intercept (ng/L)		Standard Error of the Intercept (ng/L)	F Statistic: Slope=1, Intercept=0	Correlation Between Tenax and Canister
Tetrachloro-ethylene	1) Tenax - 5L	5	1.130	0.982	0.203		33.544	1.4810	0.553
	2) Tenax - 10L	5	1.110	0.497	-3.693		16.977	0.0305	0.790
	4) Tenax - 20L	5	1.928	0.609	-30.645		20.797	1.3218	0.677
	5) Tenax - 40L	5	1.332	0.510	-10.777		17.427	0.2767	0.633
	6) Tenax - All Volumes	5	1.340	0.592	-10.230		20.219	0.4989	0.794
	Experiment Type								
Toluene	1) Tenax - 5L	5	1.111	0.203	1.573		5.258	2.5578	0.953
	2) Tenax - 10L	5	1.083	0.095	-0.491		2.468	1.7386	0.989
	4) Tenax - 20L	5	1.083	0.131	-0.651		3.399	0.7825	0.979
	5) Tenax - 40L	5	1.039	0.050	-1.046		1.291	0.3325	0.997
	6) Tenax - All Volumes	5	1.083	0.102	-0.274		2.631	1.9248	0.987
	Experiment Type								
Trichloro-ethylene	1) Tenax - 5L	5	0.924	0.055	0.509		0.606	1.0287	0.995
	2) Tenax - 10L	5	0.855	0.028	0.363		0.311	21.3546	0.998
	4) Tenax - 20L	5	0.907	0.059	0.204		0.654	2.0711	0.994
	5) Tenax - 40L	5	0.922	0.022	-0.097		0.248	16.1891	0.999
	6) Tenax - All Volumes	5	0.902	0.024	0.245		0.271	12.9723	0.999
	Experiment Type								

(CONTINUED)

F values with 2 numerator and 3 denominator df
p=0.01, F=30.82; p=0.05, F=9.55

TABLE IIIA
Tenax Distributed Air Volume System: Experiments 6-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Slope	Standard Error of the Slope	Intercept		Standard Error of the Intercept (ng/L)	F Statistic: Slope=1, Intercept=0	Correlation Between Tenax and Canister
					(ng/L)				
1,1,1-Trichloroethane	1) Tenax - 5L	5	1.044	0.080	-0.056		1.159	0.4482	0.991
	2) Tenax - 10L	5	0.961	0.077	-0.754		1.120	2.1820	0.991
	4) Tenax - 20L	5	0.715	0.085	0.886		1.235	13.1905	0.980
	5) Tenax - 40L	5	0.777	0.022	-0.800		0.316	265.9275	0.999
	6) Tenax - All Volumes	5	0.874	0.040	-0.181		0.584	19.6835	0.997

F values with 2 numerator and 3 denominator df
 $p=0.01$, $F=30.82$; $p=0.05$, $F=9.55$

TABLE IIIB
Tenax Distributed Air Volume System: Experiments 6-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Root Mean Square Error From Regression	Pooled Standard Deviation	F Statistic: Slopes Homogeneous	F Statistic: Nominal Volume Effect	Mean of the Tenax Values (ng/l)		Minimum of the Tenax Values (ng/l)	Maximum of the Tenax Values (ng/l)
			(ng/l)	(ng/l)					(ng/l)	(ng/l)
Benzene	1) Tenax - 5L	5	2.462	5.360			14.500		3.800	26.300
	2) Tenax - 10L	5	2.996	2.140			14.500		2.550	25.850
	4) Tenax - 20L	5	2.531	0.359			15.070		4.550	26.600
	5) Tenax - 40L	5	2.505	0.348			14.550		3.700	26.600
	6) Tenax - All Volumes	5	1.851	2.897	0.4400	0.0600	14.655		2.550	26.600
Bromodichloro- methane	1) Tenax - 5L	5	0.764	0.630			7.770		0.150	16.200
	2) Tenax - 10L	5	0.521	1.577			7.150		0.150	15.550
	4) Tenax - 20L	5	0.747	0.261			7.060		0.200	16.150
	5) Tenax - 40L	5	0.389	0.286			6.960		0.250	15.350
	6) Tenax - All Volumes	5	0.436	0.871	0.7100	1.8100	7.235		0.150	16.200
Chloroform	1) Tenax - 5L	5	2.542	0.290			12.620		1.100	28.700
	2) Tenax - 10L	5	1.844	1.730			11.420		1.000	25.750
	4) Tenax - 20L	5	1.184	2.344			9.770		0.900	21.300
	5) Tenax - 40L	5	0.520	0.672			5.220		0.400	11.850
	6) Tenax - All Volumes	5	1.375	1.502	9.6200	6.6900	9.757		0.400	28.700

(CONTINUED)

F values with 3 numerator and 12 denominator df
p=0.01, F=5.95; p=0.05, F=3.49

TABLE IIIB
Tenax Distributed Air Volume System: Experiments 6-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Root Mean Square Error From Regression		Pooled Standard Deviation	F Statistic: Slopes Homogeneous	F Statistic: Nominal Volume Effect	Mean of the Tenax Values		Minimum of the Tenax Values	Maximum of the Tenax Values
			(ng/l)	(ng/l)				(ng/l)	(ng/l)		
Hexachlorobutadiene	1) Tenax - 5L	5	0.631	0.653				8.500	0.950		19.400
	2) Tenax - 10L	5	0.698	0.651				8.910	0.900		20.400
	4) Tenax - 20L	5	0.519	0.402				9.220	1.000		22.050
	5) Tenax - 40L	5	0.310	0.601				9.990	1.000		23.200
	6) Tenax - All Volumes	5	0.298	0.647	3.9500	3.9900	9.155	0.900			23.200
	Experiment Type										
P-Dichlorobenzene	1) Tenax - 5L	5	0.697	0.482				8.080	3.650		14.400
	2) Tenax - 10L	5	0.550	0.689				7.630	3.550		13.750
	4) Tenax - 20L	5	0.488	0.464				7.730	3.800		14.500
	5) Tenax - 40L	5	0.315	0.397				7.600	3.500		13.900
	6) Tenax - All Volumes	5	0.363	0.520	0.4600	0.9700	7.760	3.500			14.500
	Experiment Type										
Styrene	1) Tenax - 5L	5	1.153	0.501				7.230	0.900		14.950
	2) Tenax - 10L	5	0.837	0.644				6.900	0.950		14.700
	4) Tenax - 20L	5	0.346	0.279				6.900	1.050		15.200
	5) Tenax - 40L	5	0.776	0.321				6.790	0.900		14.500
	6) Tenax - All Volumes	5	0.756	0.537	0.0900	0.3200	6.955	0.900			15.200
	Experiment Type										

(CONTINUED)

F values with 3 numerator and 12 denominator df
p=0.01, F=5.95; p=0.05, F=3.49

TABLE IIIB
Tenax Distributed Air Volume System: Experiments 6-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Root Mean Square Error From Regression (ng/l)	Pooled Standard Deviation (ng/l)	F Statistic: Slopes Homogeneous	F Statistic: Nominal Volume Effect	Mean of the Tenax Values (ng/l)	Minimum of the Tenax Values (ng/l)	Maximum of the Tenax Values (ng/l)
Tetrachloro- ethylene	1) Tenax - 5L	5	6.045	2.887			38.680	30.150	47.100
	2) Tenax - 10L	5	3.060	4.837			33.890	26.900	37.500
	4) Tenax - 20L	5	3.748	1.307			34.990	24.050	41.650
	5) Tenax - 40L	5	3.141	2.307			34.550	27.850	40.600
	6) Tenax - All Volumes	5	3.644	3.124	0.3200	1.5300	35.527	24.050	47.100
	Experiment Type								
Toluene	1) Tenax - 5L	5	4.332	2.115			28.300	7.600	36.900
	2) Tenax - 10L	5	2.033	3.324			25.550	6.600	35.000
	4) Tenax - 20L	5	2.800	0.994			25.400	6.850	37.450
	5) Tenax - 40L	5	1.064	1.647			23.950	6.250	32.900
	6) Tenax - All Volumes	5	2.168	2.196	0.0500	2.5600	25.800	6.250	37.450
	Experiment Type								
Trichloro- ethylene	1) Tenax - 5L	5	0.905	0.581			8.140	0.200	16.800
	2) Tenax - 10L	5	0.465	1.308			7.430	0.250	16.350
	4) Tenax - 20L	5	0.977	0.279			7.700	0.300	18.000
	5) Tenax - 40L	5	0.370	0.567			7.520	0.300	17.200
	6) Tenax - All Volumes	5	0.404	0.782	0.5300	1.0300	7.697	0.200	18.000
	Experiment Type								

(CONTINUED)

F values with 3 numerator and 12 denominator df
D=0.01, F=5.95; D=0.05, F=3.49

TABLE IIIB
Tenax Distributed Air Volume System: Experiments 6-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Root Mean Square Error From Regression		Pooled Standard Deviation	F Statistic: Slopes Homogeneous	F Statistic: Nominal Volume Effect	Mean of the Tenax Values		Minimum of the Tenax Values	Maximum of the Tenax Values
			(ng/l)	(ng/l)				(ng/l)	(ng/l)		
1,1,1-Trichloroethane	1) Tenax - 5L	5	1.402	1.294				12.720	2.550	24.400	
	2) Tenax - 10L	5	1.354	1.353				11.010	1.350	21.550	
	4) Tenax - 20L	5	1.493	3.259				9.640	2.350	17.250	
	5) Tenax - 40L	5	0.362	0.251				8.710	1.750	16.850	
	6) Tenax - All Volumes	5	0.706	1.884	4.7500	5.6300		10.520	1.350	24.400	

TABLE IIIC
Tenax Distributed Air Volume System: Experiments 6-11
Summary of Tests of Significance for the Slope and Intercept
From the Regression Analysis of Tenax Means on Canister Means

Compound	Alpha, Beta		Alpha		Beta		Heterogeneity of Slopes	Nominal Volume
	Nominal Volume	5 10 20 40 All	Nominal Volume	5 10 20 40 All	Nominal Volume	5 10 20 40 All		
Benzene								
Bromodichloromethane	*	***	*		*	***	*	
Chloroform							**	**
Hexachlorobutadiene	*						*	*
P-Dichlorobenzene								
Styrene			*		*			
Tetrachloroethylene					00 00 00 00 00			
Toluene					0			
Trichloroethylene	*	*			*	*	*	*
1,1,1-Trichloroethane		***	*		***		*	*

*: Null hypothesis rejected at the 0.05 significance level and not rejected at the 0.01 significance level.
 **: Null hypothesis rejected at the 0.01 significance level.
 00: Null hypothesis: Slope=0 not rejected at the 0.05 significance level.
 0: Null hypothesis: Slope=0 rejected at the 0.05 significance level and not rejected at the 0.01 significance level

TABLE IVA
Tenax Distributed Air Volume System: Experiments 1-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Slope	Standard Error of the Slope	Intercept		Standard Error of the Intercept	F Statistic: Slope=1, Intercept=0	Correlation Between Tenax and Canister
					(ng/L)				
Benzene	1) Tenax - 5L	10	0.968	0.158	-0.839		2.398	0.8300	0.908
	2) Tenax - 10L	10	1.099	0.153	-2.777		2.327	1.2660	0.930
	3) Tenax - 15L	5	1.282	0.705	-4.991		8.832	0.3038	0.724
	4) Tenax - 20L	10	1.107	0.149	-2.739		2.268	1.1362	0.934
	5) Tenax - 40L	5	1.130	0.136	-2.819		2.374	0.7241	0.979
	6) Tenax - All Volumes	10	1.081	0.141	-2.405		2.140	1.1939	0.938
Bromodichloromethane	Experiment Type								
	1) Tenax - 5L	10	0.920	0.034	0.101		0.274	4.1719	0.995
	2) Tenax - 10L	10	0.842	0.021	0.315		0.170	37.8267	0.998
	3) Tenax - 15L	5	0.915	0.062	0.027		0.217	2.6214	0.993
	4) Tenax - 20L	10	0.842	0.026	0.299		0.213	24.3162	0.996
	5) Tenax - 40L	5	0.841	0.023	0.238		0.255	40.7056	0.999
Chloroform	6) Tenax - All Volumes	10	0.862	0.018	0.234		0.146	40.7587	0.998
	Experiment Type								
	1) Tenax - 5L	10	1.018	0.070	-0.053		0.822	0.0461	0.982
	2) Tenax - 10L	10	0.932	0.049	0.046		0.580	1.6774	0.989
	3) Tenax - 15L	5	0.893	0.050	0.036		0.278	6.6587	0.995

(CONTINUED)

F values with 2 numerator and N-2 denominator df
N=5: p=0.01, F=30.82; p=0.05, F=9.55
N=10: p=0.01, F=8.65; p=0.05, F=4.46

TABLE IVA
Tenax Distributed Air Volume System: Experiments 1-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Slope	Standard Error of the Slope	Intercept (ng/L)		Standard Error of the Intercept (ng/L)	F Statistic: Slope=1, Intercept=0	Correlation Between Tenax and Canister
Chloroform	4) Tenax - 20L	10	0.808	0.028	0.241		0.326	39.9877	0.995
	5) Tenax - 40L	5	0.480	0.022	-0.388		0.347	662.4583	0.997
	6) Tenax - All Volumes	10	0.802	0.032	0.311		0.376	30.6389	0.994
Hexachloro-butadiene	Experiment Type								
	1) Tenax - 5L	10	0.912	0.036	-0.384		0.336	9.1179	0.994
	2) Tenax - 10L	10	0.941	0.051	0.030		0.473	1.0717	0.989
	3) Tenax - 15L	5	1.057	1.133	-1.582		2.690	0.3829	0.687
	4) Tenax - 20L	10	0.987	0.041	-0.496		0.365	1.9167	0.993
	5) Tenax - 40L	5	1.045	0.016	-0.117		0.208	6.5895	1.000
P-Dichloro-benzene	6) Tenax - All Volumes	10	0.969	0.033	-0.181		0.307	1.6417	0.995
	Experiment Type								
	1) Tenax - 5L	10	1.029	0.046	0.325		0.322	4.0027	0.992
	2) Tenax - 10L	10	0.954	0.065	0.466		0.456	0.5547	0.982
	3) Tenax - 15L	5	1.310	0.282	-1.138		1.255	0.6385	0.937
	4) Tenax - 20L	10	0.986	0.054	0.016		0.379	0.0867	0.988
	5) Tenax - 40L	5	0.957	0.031	0.390		0.272	1.0727	0.998
	6) Tenax - All Volumes	10	0.992	0.047	0.226		0.329	0.5028	0.991

(CONTINUED)

F values with 2 numerator and N-2 denominator df
N=5: p=0.01; F=30.82; p=0.05; F=9.55
N=10: p=0.01; F=8.65; p=0.05; F=4.46

TABLE IVA
Tenax Distributed Air Volume System: Experiments 1-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Slope	Standard Error of the Slope	Intercept (ng/L)	Standard Error of the Intercept (ng/L)	F Statistic: Slope=1, Intercept=0	Correlation Between Tenax and Canister
Styrene	1) Tenax - 5L	10	0.959	0.051	0.828	0.342	3.5835	0.989
	2) Tenax - 10L	10	0.922	0.037	0.792	0.246	5.2026	0.994
	3) Tenax - 15L	5	1.181	0.104	0.270	0.292	10.6674	0.989
	4) Tenax - 20L	10	0.924	0.022	0.693	0.147	11.1960	0.998
	5) Tenax - 40L	5	0.899	0.058	0.797	0.517	1.5958	0.994
	6) Tenax - All Volumes	10	0.928	0.036	0.786	0.239	5.4443	0.994
Tetrachloro-ethylene	Experiment Type							
	1) Tenax - 5L	10	1.174	0.122	-1.268	3.804	5.3666	0.959
	2) Tenax - 10L	10	1.010	0.086	0.612	2.670	0.4871	0.972
	3) Tenax - 15L	5	1.205	0.054	-1.871	1.514	16.9292	0.997
	4) Tenax - 20L	10	1.103	0.109	-0.989	3.381	1.9969	0.963
	5) Tenax - 40L	5	1.332	0.510	-10.777	17.427	0.2767	0.833
Toluene	6) Tenax - All Volumes	10	1.095	0.086	-0.723	2.682	3.1746	0.976
	Experiment Type							
	1) Tenax - 5L	10	1.098	0.090	1.372	2.409	7.0024	0.974
	2) Tenax - 10L	10	1.055	0.053	0.673	1.553	4.7817	0.988
	3) Tenax - 15L	5	1.002	0.075	2.546	2.092	3.2498	0.992

F values with 2 numerator and N-2 denominator df
N=5: p=0.01; F=30.83; p=0.05; F=9.55
N=10: p=0.01; F=6.05; p=0.05; F=4.46

(CONTINUED)

TABLE IVA
Tenax Distributed Air Volume System: Experiments 1-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Slope	Standard Error of the Slope	Intercept (ng/L)	Standard Error of the Intercept (ng/L)	F Statistic: Slope=1, Intercept=0	Correlation Between Tenax and Canister
Toluene	4) Tenax - 20L	10	0.947	0.069	2.697	1.845	1.8431	0.980
	5) Tenax - 40L	5	1.039	0.050	-1.046	1.291	0.3325	0.997
	6) Tenax - All Volumes	10	1.030	0.056	1.359	1.511	5.1859	0.988
	Experiment Type							
	1) Tenax - 5L	10	0.949	0.036	0.111	0.296	1.3468	0.994
	2) Tenax - 10L	10	0.870	0.022	0.207	0.185	24.9234	0.997
Trichloroethylene	3) Tenax - 15L	5	1.109	0.079	-0.419	0.291	1.0853	0.992
	4) Tenax - 20L	10	0.920	0.033	0.015	0.277	5.1854	0.995
	5) Tenax - 40L	5	0.922	0.022	-0.097	0.248	16.1891	0.999
	6) Tenax - All Volumes	10	0.916	0.019	0.089	0.160	15.1635	0.998
	Experiment Type							
	1) Tenax - 5L	10	1.056	0.055	-0.618	0.626	0.5558	0.990
1,1,1-Trichloroethane	2) Tenax - 10L	10	0.933	0.045	-0.228	0.515	5.2902	0.991
	3) Tenax - 15L	5	0.892	0.087	0.396	0.627	1.4290	0.986
	4) Tenax - 20L	10	0.714	0.050	1.144	0.578	26.7650	0.931
	5) Tenax - 40L	5	0.777	0.022	-0.800	0.316	265.9275	0.999
	6) Tenax - All Volumes	10	0.857	0.028	0.236	0.324	30.1468	0.996

F values with 2 numerator and N-2 denominator df
 N=5: p=0.01, F=39.63; p=0.05, F=9.55
 N=10: p=0.01, F=8.63; p=0.05, F=4.46

TABLE IVB
Tenax Distributed Air Volume System: Experiments 1-11
Summary Statistics from Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Root Mean Square Error From Regression	Pooled Standard Deviation	F Statistic: Slopes Homogeneous	F Statistic: Nominal Volume Effect	Mean of the Tenax Values (ng/l)		Minimum of the Tenax Values (ng/l)		Maximum of the Tenax Values (ng/l)	
			(ng/l)	(ng/l)			(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)
Benzene	1) Tenax - 5L	10	3.173	3.860			12.510	2.350			26.300	
	2) Tenax - 10L	10	3.079	1.687			12.370	2.550			25.850	
	3) Tenax - 15L	5	4.432	0.910			10.660	2.350			17.500	
	4) Tenax - 20L	10	3.000	0.326			12.530	2.550			26.600	
	5) Tenax - 40L	5	2.505	0.348			14.550	3.700			26.600	
	6) Tenax - All Volumes	10	2.831	2.141	0.1900	0.0200	12.504	2.350			26.600	
Bromodichloro- methane	Experiment Type											
	1) Tenax - 5L	10	0.642	0.494			5.115	0.100			16.200	
	2) Tenax - 10L	10	0.398	1.124			4.905	0.100			15.550	
	3) Tenax - 15L	5	0.268	0.336			2.690	0.100			5.100	
	4) Tenax - 20L	10	0.499	0.212			4.890	0.150			16.150	
	5) Tenax - 40L	5	0.389	0.286			6.960	0.250			15.350	
Chloroform	6) Tenax - All Volumes	10	0.342	0.642	1.7300	0.4800	4.934	0.100			16.200	
	Experiment Type											
	1) Tenax - 5L	10	1.880	0.352			8.250	0.350			28.700	
	2) Tenax - 10L	10	1.326	1.243			7.650	0.500			25.750	
	3) Tenax - 15L	5	0.350	0.251			4.170	0.300			8.150	
	4) Tenax - 20L	10	0.746	1.658			6.830	0.350			21.300	

F values with 3 numerator and 32 denominator df
p=0.01, F=4.46; p=0.05, F=2.90

(CONTINUED)

TABLE IVB
Tenax Distributed Air Volume System: Experiments 1-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Root Mean Square Error From Regression (ng/l)	Pooled Standard Deviation (ng/l)	F Statistic: Slopes Homogeneous	F Statistic: Nominal Volume Effect	Mean of the Tenax Values (ng/l)		Minimum of the Tenax Values (ng/l)		Maximum of the Tenax Values (ng/l)	
Chloroform	5) Tenax - 40L	5	0.520	0.672				5.220	0.400		11.650	
	6) Tenax - All Volumes	10	0.860	1.061	15.9100	7.2600		6.856	0.300		28.700	
Hexachloro- butadiene	Experiment Type											
	1) Tenax - 5L	10	0.818	0.486				5.060	0.950		19.400	
	2) Tenax - 10L	10	1.152	0.673				5.645	0.900		20.400	
	3) Tenax - 15L	5	1.619	0.952				2.620	1.000		5.650	
	4) Tenax - 20L	10	0.936	0.315				5.395	1.000		22.050	
	5) Tenax - 40L	5	0.310	0.601				9.990	1.000		23.200	
p-Dichloro- benzene	6) Tenax - All Volumes	10	0.746	0.596	1.4600	1.8100		5.601	0.900		23.200	
	Experiment Type											
	1) Tenax - 5L	10	0.565	0.526				6.300	1.350		14.400	
	2) Tenax - 10L	10	0.799	0.743				6.005	1.950		13.750	
	3) Tenax - 15L	5	1.126	0.446				4.210	0.450		7.050	
	4) Tenax - 20L	10	0.663	0.369				5.740	0.700		14.500	
	5) Tenax - 40L	5	0.315	0.397				7.600	3.500		13.900	
	6) Tenax - All Volumes	10	0.576	0.535	1.0600	0.8100		5.987	0.450		14.500	

(CONTINUED)

F values with 3 numerator and 32 denominator df
p=0.01, f=4.46; p=0.05, f=2.90

TABLE IVB
Tenax Distributed Air Volume System: Experiments 1-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Root Mean Square Error From Regression (ng/l)	Pooled Standard Deviation (ng/l)	F Statistic: Slopes Homogeneous	F Statistic: Nominal Volume Effect	Mean of the Tenax Values (ng/l)	Minimum of the Tenax Values (ng/l)	Maximum of the Tenax Values (ng/l)
Styrene	1) Tenax - 5L	10	0.798	0.398			5.145	0.450	14.950
	2) Tenax - 10L	10	0.572	0.614			4.940	0.650	14.700
	3) Tenax - 15L	5	0.363	0.243			3.030	0.450	5.200
	4) Tenax - 20L	10	0.342	0.212			4.850	0.550	15.200
	5) Tenax - 40L	5	0.776	0.321			6.790	0.900	14.500
	6) Tenax - All Volumes	10	0.557	0.407	0.8100	0.4700	4.961	0.450	15.200
Tetrachloro- ethylene	Experiment Type								
	1) Tenax - 5L	10	4.104	3.548			33.115	11.750	50.000
	2) Tenax - 10L	10	2.680	4.622			30.180	12.000	50.550
	3) Tenax - 15L	5	1.600	2.070			27.700	12.300	53.150
	4) Tenax - 20L	10	3.647	1.124			31.315	11.850	52.050
	5) Tenax - 40L	5	3.141	2.307			34.550	27.850	40.600
	6) Tenax - All Volumes	10	2.892	3.152	0.5500	1.6200	31.434	11.750	53.150
Toluene	Experiment Type								
	1) Tenax - 5L	10	3.314	2.176			27.910	7.600	54.500
	2) Tenax - 10L	10	2.137	3.234			26.150	6.600	53.000
	3) Tenax - 15L	5	2.271	2.615			26.860	8.900	51.150
	4) Tenax - 20L	10	2.533	0.699			25.570	6.650	47.000

(CONTINUED)

F values with 3 numerator and 32 denominator df
p=0.01, F=4.46; p=0.05, F=2.90

TABLE IVB
Tenax Distributed Air Volume System: Experiments 1-11
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	Experiment Type	N	Root Mean Square Error From Regression		Pooled Standard Deviation	F Statistic: Homogeneous Slopes	F Statistic: Nominal Volume Effect	Mean of the Tenax Values		Minimum of the Tenax Values		Maximum of the Tenax Values	
			(ng/l)	(ng/l)				(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)
Toluene	5) Tenax - 40L	5	1.664		1.647			23.950		6.250		32.900	
	6) Tenax - All Volumes	10	2.079		2.282	0.6700	2.3000	26.259		6.250		54.500	
	Experiment Type												
	1) Tenax - 5L	10	0.661		0.459			5.495		0.150		16.800	
	2) Tenax - 10L	10	0.425		0.938			5.140		0.200		16.350	
	3) Tenax - 15L	5	0.356		0.326			3.000		0.150		5.800	
Trichloro-ethylene	4) Tenax - 20L	10	0.636		0.220			5.235		0.150		18.000	
	5) Tenax - 40L	5	0.370		0.567			7.520		0.300		17.200	
	6) Tenax - All Volumes	10	0.366		0.561	1.5900	0.6200	5.262		0.150		18.000	
	Experiment Type												
	1) Tenax - 5L	10	1.143		0.973			9.275		1.600		24.400	
	2) Tenax - 10L	10	0.940		1.074			8.515		1.350		21.550	
1,1,1-Trichloro-ethane	3) Tenax - 15L	5	0.602		0.454			6.200		2.300		10.100	
	4) Tenax - 20L	10	1.055		2.307			7.835		2.350		17.250	
	5) Tenax - 40L	5	0.382		0.251			8.710		1.750		16.850	
	6) Tenax - All Volumes	10	0.592		1.375	8.1000	5.0200	8.270		1.350		24.400	
	Experiment Type												
	1) Tenax - 5L	10	1.143		0.973			9.275		1.600		24.400	

F values with 3 numerator and 32 denominator df
p=0.01, F=4.46; p=0.05, F=2.90

TABLE IVC
Tenax Distributed Air Volume System: Experiments 1-11
Summary of Tests of Significance for the Slope and Intercept
From the Regression Analysis of Tenax Means on Canister Means

Compound	Alpha, Beta		Alpha		Beta		Heterogeneity of Slopes	Nominal Volume						
	Nominal Volume		Nominal Volume		Nominal Volume									
	5	10	15	20	40	All			5	10	15	20	40	All
Benzene											00			
Bromodichloromethane	**	**	**	**	**	**		**	**	**	**	**	**	
Chloroform		**	**	**	**	**		**	**	**	**	**	**	**
Hexachlorobutadiene	**						*	00						**
P-Dichlorobenzene								0						
Styrene	*	*	*	*	*	*	*	**	**	**	**	**	**	
Tetrachloroethylene	*	*						*	00					
Toluene	*	*			*									
Trichloroethylene	**	*	*	*	*	*		**	*	*	*	*	*	
1,1,1-Trichloroethane	*	*	*	*	*	*		*	*	*	*	*	*	**

*: Null hypothesis rejected at the 0.05 significance level
and not rejected at the 0.01 significance level.
*: Null hypothesis rejected at the 0.01 significance level.
00: Null hypothesis: Slope=0 not rejected at the 0.05 significance level.
0: Null hypothesis: Slope=0 rejected at the 0.05 significance level
and not rejected at the 0.01 significance level

TABLE VA
Tenax Personal Sampling Device: Low Rate Sampler
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	N	Slope	Standard Error of the Slope	Intercept		Standard Error of the Intercept	F Statistic: Slope=1, Intercept=0	Correlation Between Tenax and Canister
				(ng/L)	(ng/L)			
Benzene	10	0.710	0.206	-0.690		3.128	7.4296	0.773
Bromodichloromethane	10	0.727	0.021	-0.043		0.170	158.3597	0.997
Chloroform	10	0.640	0.025	-0.163		0.297	207.3874	0.994
Hexachlorobutadiene	10	0.559	0.073	-0.125		0.684	31.8242	0.938
p-Dichlorobenzene	10	0.703	0.061	-0.532		0.428	57.0419	0.971
Styrene	10	0.567	0.032	0.123		0.213	159.2375	0.988
Tetrachloroethylene	10	0.510	0.063	0.689		1.971	236.0023	0.944
Toluene	10	0.608	0.048	-1.238		1.287	215.6872	0.976
Trichloroethylene	10	0.641	0.025	0.027		0.204	198.6679	0.994
1,1,1-Trichloroethane	8	0.629	0.125	1.319		1.578	9.2513	0.900

F values with 2 numerator and N-2 denominator df
 N=8 : p=0.01; F=10.92; p=0.05; F=5.14
 N=9 : p=0.01; F=9.55; p=0.05; F=4.74
 N=10 : p=0.01; F=8.65; p=0.05; F=4.46

TABLE VB
Tenax Personal Sampling Device: Low Rate Sampler
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	N	Root Mean Square Error From Regression	Pooled Standard Deviation	Mean of the Tenax Values	Minimum of the Tenax Values	Maximum of the Tenax Values
		(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)
Benzene	10	4.138	7.688	9.092	0.123	18.361
Bromodichloromethane	10	0.398	0.581	3.921	0.164	13.238
Chloroform	10	0.678	0.419	5.055	0.164	16.393
Hexachlorobutadiene	10	1.664	2.217	3.213	1.148	15.287
p-Dichlorobenzene	10	0.750	0.628	3.551	1.189	10.410
Styrene	10	0.496	0.543	2.675	0.082	9.139
Tetrachloroethylene	10	2.126	1.729	15.638	4.795	23.607
Toluene	10	1.771	3.673	13.463	2.910	30.000
Trichloroethylene	10	0.469	0.451	3.661	0.246	11.967
1,1,1-Trichloroethane	8	2.403	0.933	8.028	3.361	16.475

TABLE VC
Tenax Personal Sampling Device: Low Rate Sampler
Summary of Tests of Significance for the Slope and Intercept
From the Regression Analysis of Tenax Means on Canister Means

Compound	Alpha,Beta	Alpha	Beta
Benzene	*		
Bromodichloromethane	**		**
Chloroform	**		**
Hexachlorobutadiene	**		**
P-Dichlorobenzene	**		**
Styrene	**		**
Tetrachloroethylene	**		**
Toluene	**		**
Trichloroethylene	**		**
1,1,1-Trichloroethane	*		*

*: Null hypothesis rejected at the 0.05 significance level
and not rejected at the 0.01 significance level.
**: Null hypothesis rejected at the 0.01 significance level.
00: Null hypothesis: Slope=0 not rejected at the 0.05 significance level.
0: Null hypothesis: Slope=0 rejected at the 0.05 significance level
and not rejected at the 0.01 significance level

TABLE VIA
Tenax Personal Sampling Device: High Rate Sampler
Summary Statistics From Regression Analysis of
Tenax Means on Canister Means

Compound	N	Slope	Standard Error of the Slope	Intercept (ng/L)	Standard Error of the Intercept (ng/L)	F Statistic: Slope=1, Intercept=0	Correlation Between Tenax and Canister
Benzene	10	0.998	0.220	-0.959	3.341	0.2493	0.848
Bromodichloromethane	10	0.823	0.022	-0.173	0.181	67.4418	0.997
Chloroform	10	0.641	0.033	-0.649	0.385	143.5743	0.990
Hexachlorobutadiene	10	1.674	0.042	-1.528	0.396	159.5579	0.997
P-Dichlorobenzene	9	1.711	0.122	-1.607	0.861	29.5368	0.983
Styrene	10	1.338	0.054	0.424	0.361	46.2696	0.993
Tetrachloroethylene	10	1.279	0.145	2.998	4.521	28.0702	0.952
Toluene	10	1.389	0.108	0.057	2.900	34.5032	0.977
Trichloroethylene	10	1.259	0.040	-0.524	0.327	29.4539	0.996
1,1,1-Trichloroethane	9	2.612	0.219	-1.416	2.625	74.1735	0.976

F values with 2 numerator and N-2 denominator df
 N=8 : p=0.01, F=10.92; p=0.05, F=5.14
 N=9 : p=0.01, F= 9.55; p=0.05, F=4.74
 N=10: p=0.01, F= 8.65; p=0.05, F=4.46

TABLE VII
 Tenax Personal Sampling Device: High Rate Sampler
 Summary Statistics From Regression Analysis of
 Tenax Means on Canister Means

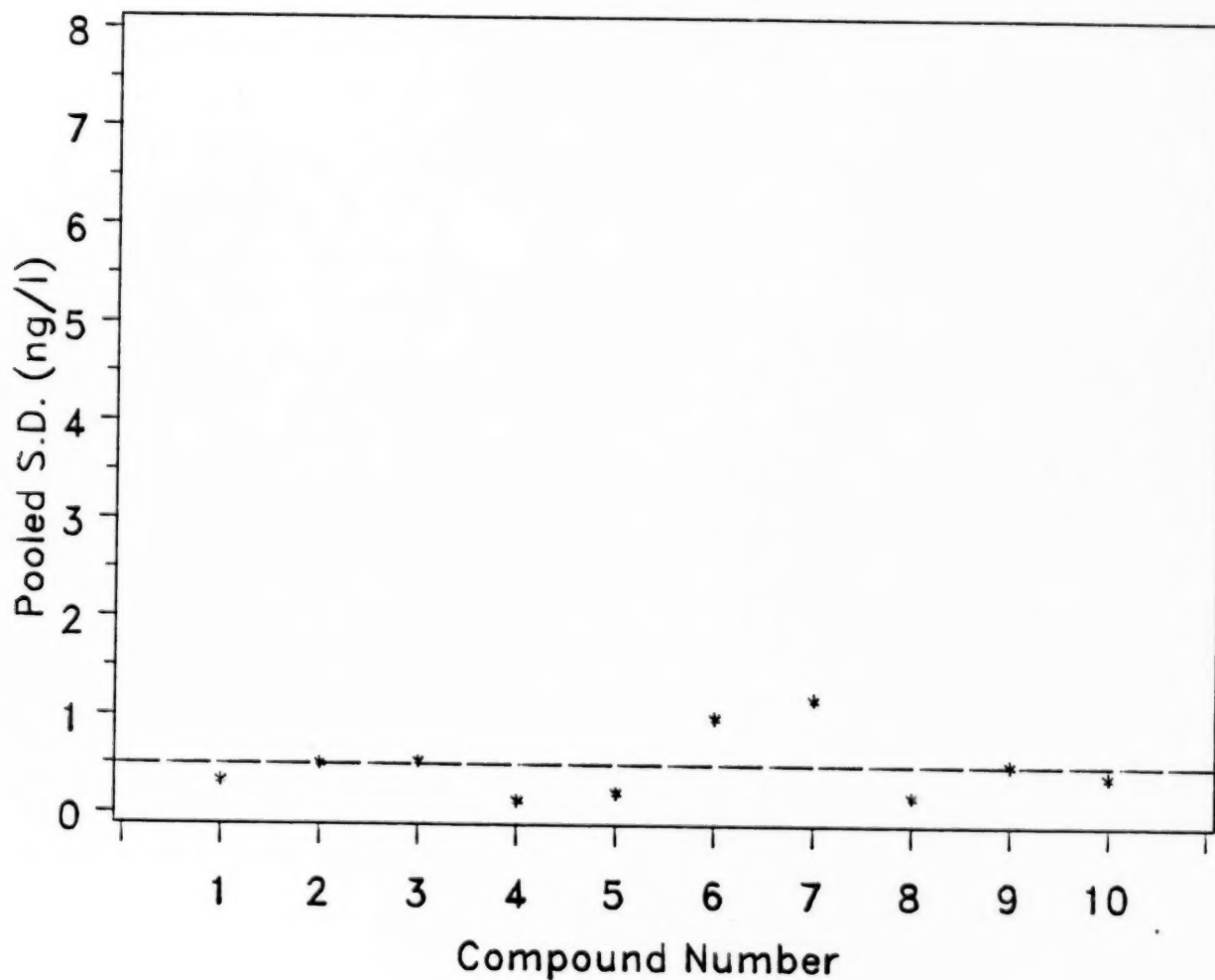
Compound	N	Root Mean Square Error From Regression	Pooled Standard Deviation	Mean of the Tenax Values	Minimum of the Tenax Values	Maximum of the Tenax Values
Benzene	10	4.420	0.544	12.600	3.200	27.850
Bromodichloroethane	10	0.423	0.143	4.315	0.300	14.650
Chloroform	10	0.880	0.492	4.575	0.300	15.800
Hexachlorobutadiene	10	0.964	2.066	8.460	1.400	36.150
P-Dichlorobenzene	9	1.491	1.211	8.252	0.850	22.750
Styrene	10	0.841	0.298	6.447	0.567	21.100
Tetrachloroethylene	10	4.876	4.582	40.453	15.633	60.500
Toluene	10	3.989	3.107	33.605	9.350	65.550
Trichloroethylene	10	0.753	0.549	6.620	0.200	22.600
1,1,1-Trichloroethane	9	4.476	1.152	24.343	4.733	57.150

TABLE VIC
Tenax Personal Sampling Device: High Rate Sampler
Summary of Tests of Significance for the Slope and Intercept
From the Regression Analysis of Tenax Means on Canister Means

Compound	Alpha, Beta	Alpha	Beta
Benzene			
Bromodichloromethane	**		**
Chloroform	**		**
Hexachlorobutadiene	**	**	**
p-Dichlorobenzene	**		**
Styrene	**		**
Tetrachloroethylene	**		
Toluene	**		**
Trichloroethylene	**		**
1,1,1-Trichloroethane	**		**

*: Null hypothesis rejected at the 0.05 significance level
and not rejected at the 0.01 significance level.
**: Null hypothesis rejected at the 0.01 significance level.
00: Null hypothesis: Slope=0 not rejected at the 0.05 significance level.
0: Null hypothesis: Slope=0 rejected at the 0.05 significance level
and not rejected at the 0.01 significance level

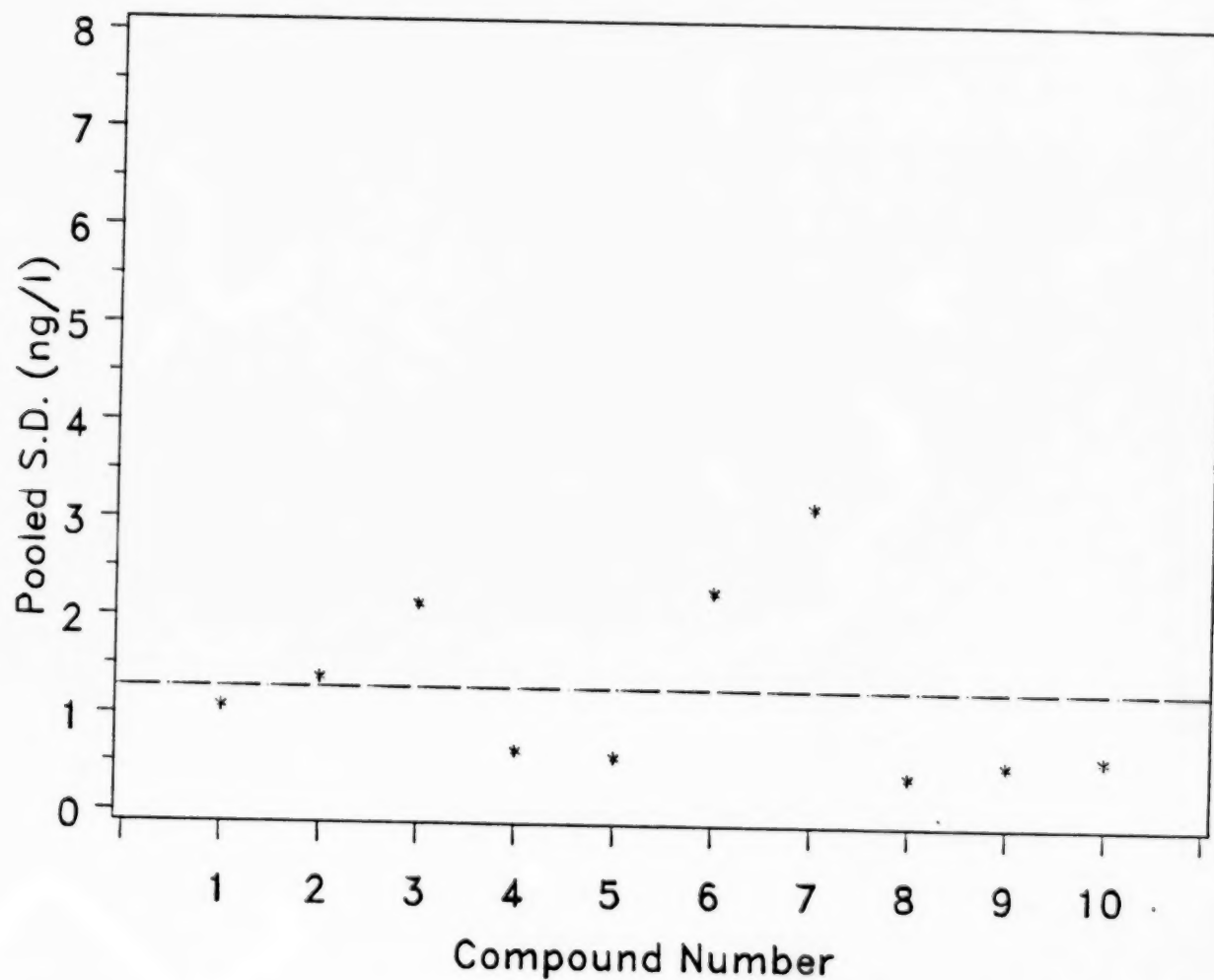
FIGURE 1
PRECISION
Canister
Standard Deviation From Pooling Variance



Data from table IC

Dashed line - mean over all values shown

FIGURE 2
PRECISION
Tenax Distributed Air Volume
Standard Deviation From Pooling Variance

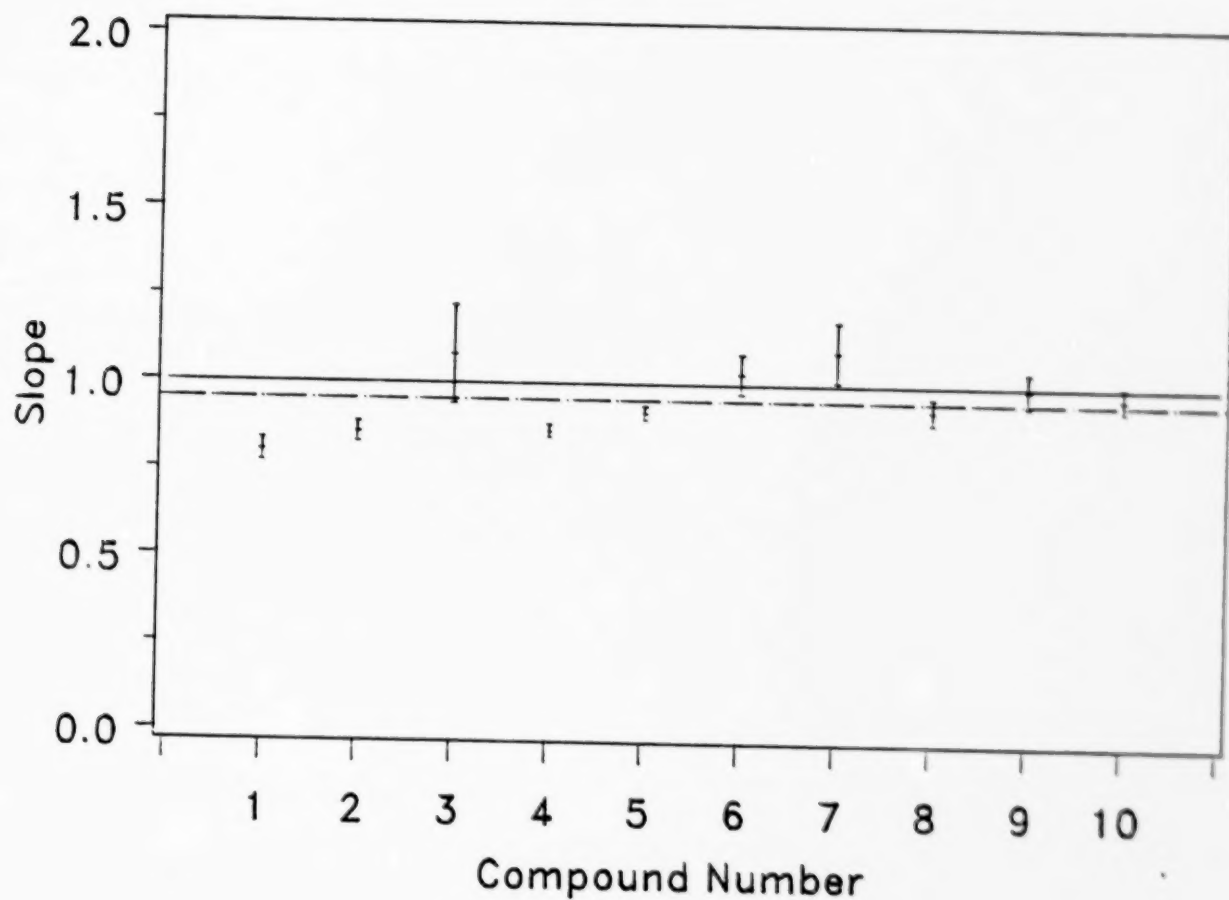


Data from table IVB

Dashed line - mean over all values shown

FIGURE 3 AGREEMENT

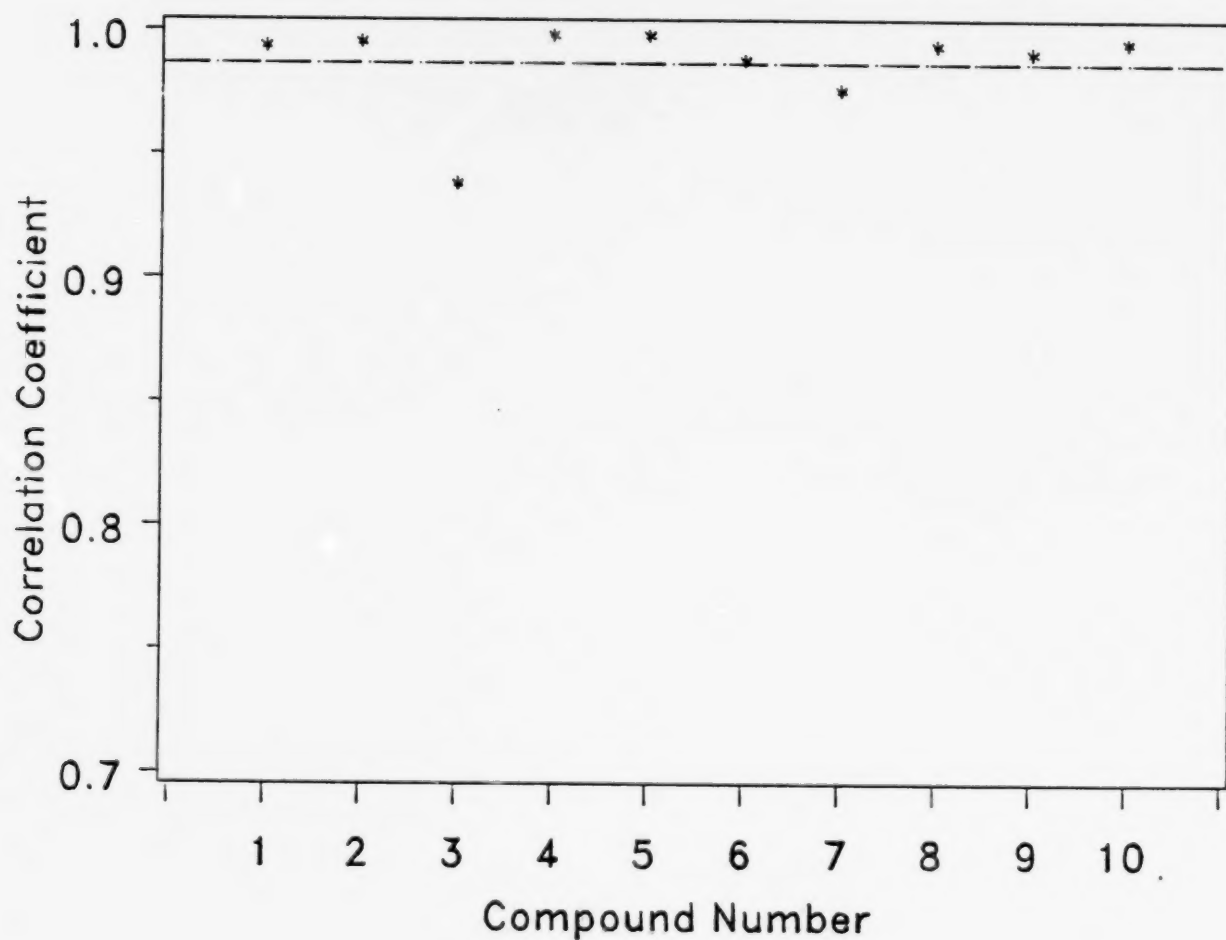
Tenax Distributed Air Volume and Canister
Slope Plus and Minus One Standard Error from the
Linear Regression of Tenax Mean vs Canister Mean
(same as Figure 23 of main text)



Data from table IVA

Dashed line - mean over all values shown

FIGURE 4
CORRELATION
Tenax Distributed Air Volume and Canister
Correlation of Tenax Mean and Canister Mean
(same as Figure 24 in main text)

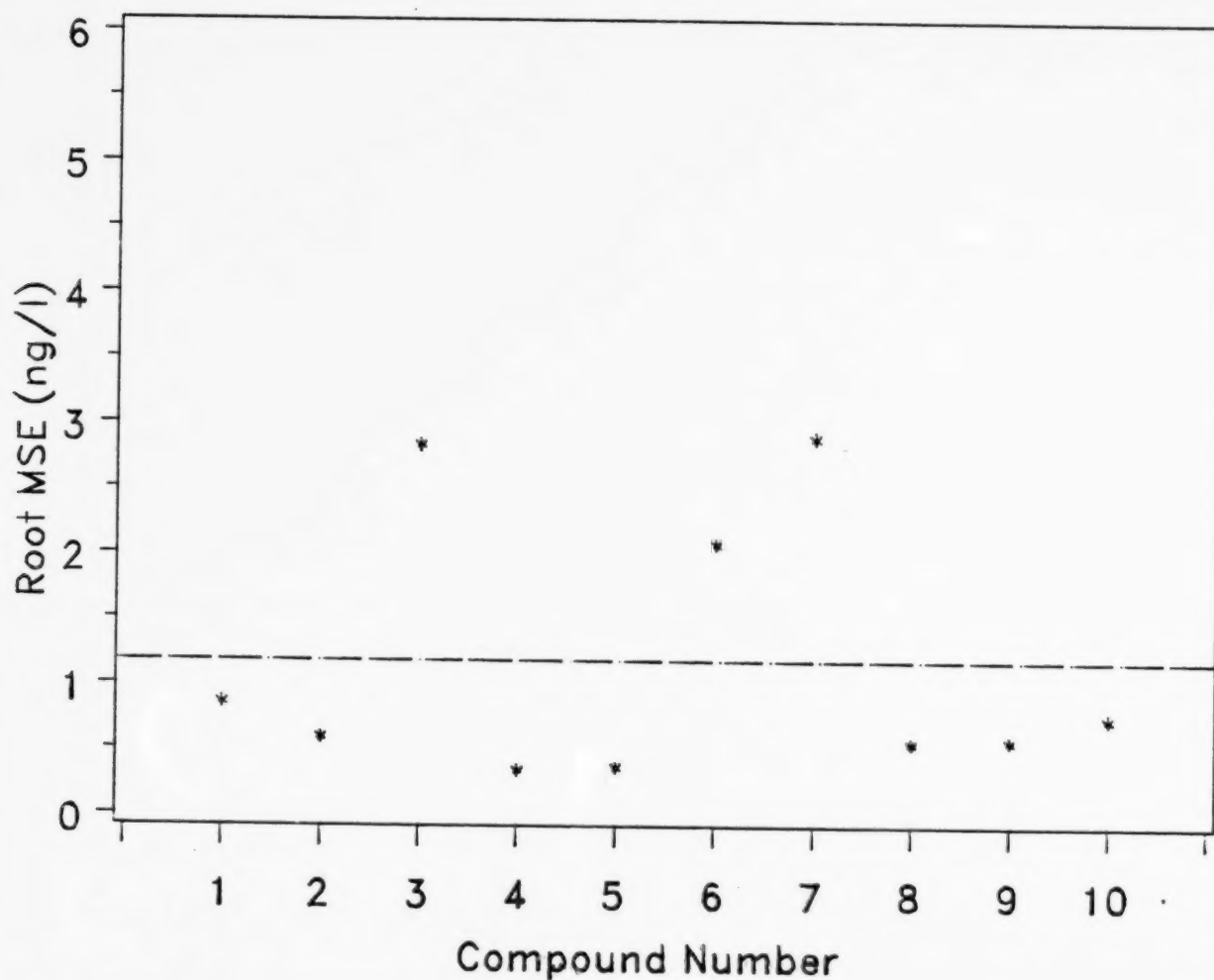


Data from table IVA

Dashed line - mean over all values shown

FIGURE 5 SCATTER

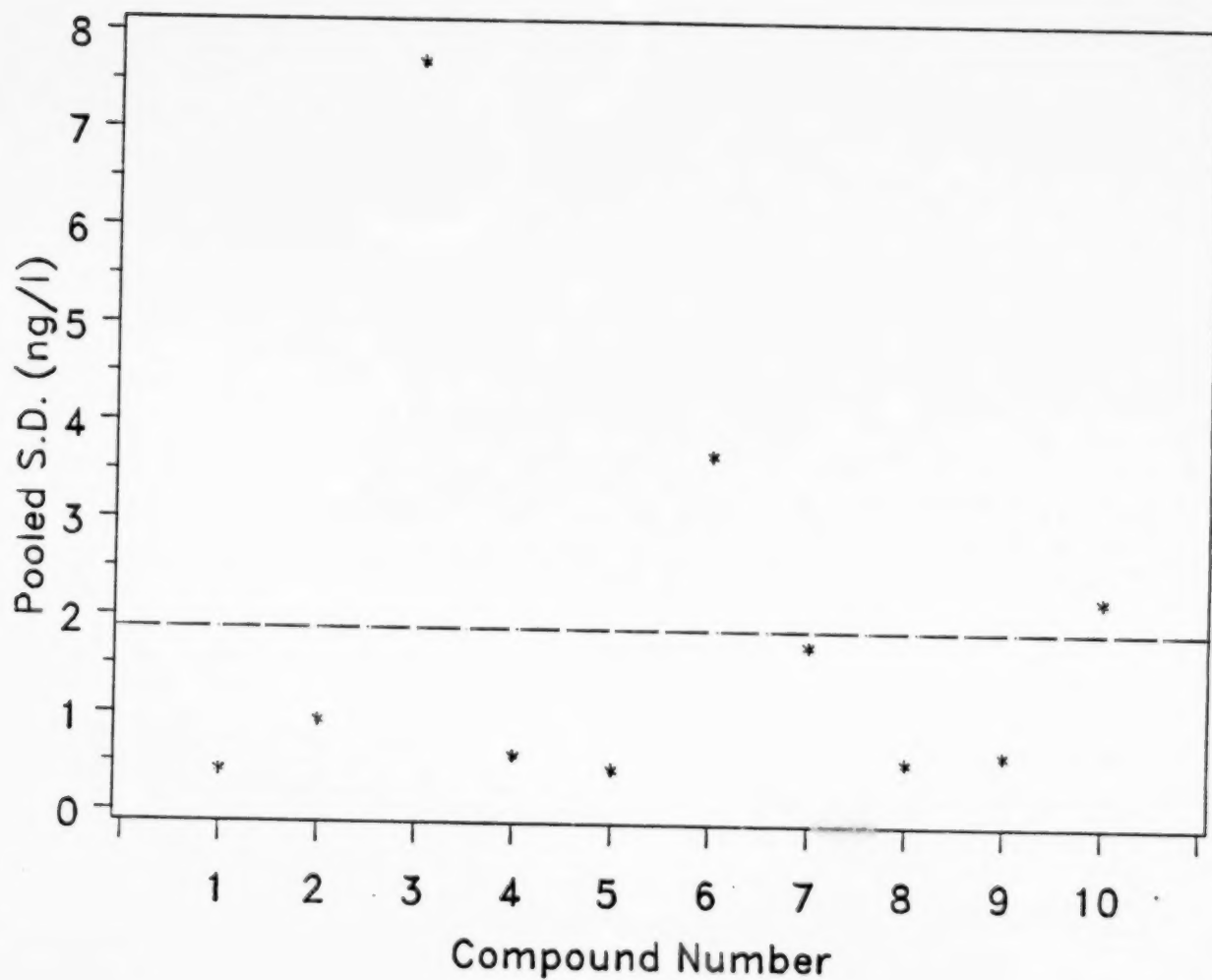
Tenax Distributed Air Volume and Canister
Linear Regression of Tenax Mean vs Canister Mean



Data from table IVB

Dashed line — mean over all values shown

FIGURE 6
PRECISION
Tenax Low Rate Personal Sampling Device
Standard Deviation From Pooling Variance



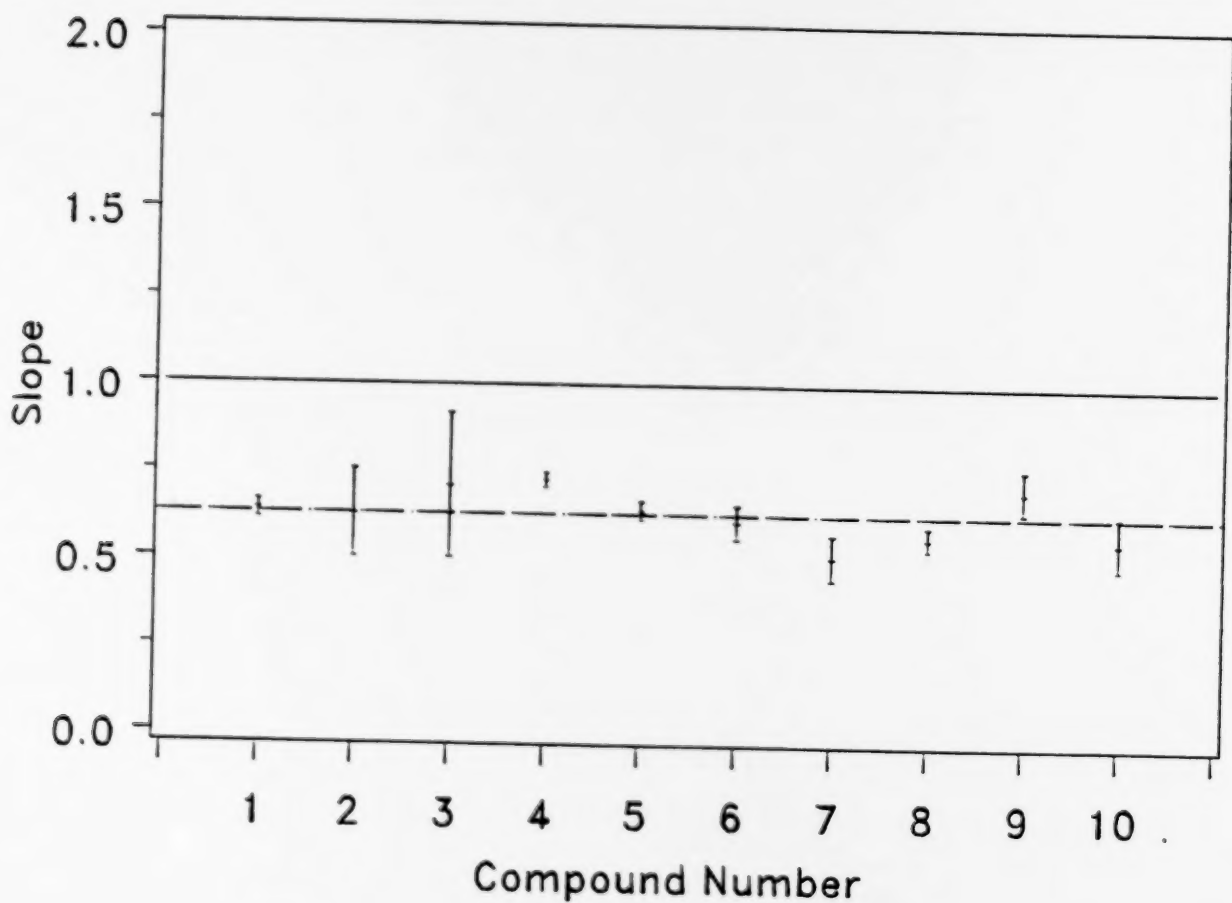
Data from table VB

Dashed line - mean over all values shown

FIGURE 7 AGREEMENT

Tenax Low Rate Personal Sampling Device and Canister
Slope Plus and Minus One Standard Error from the
Linear Regression of Tenax Mean vs Canister Mean

(same as Figure 25 in main text)

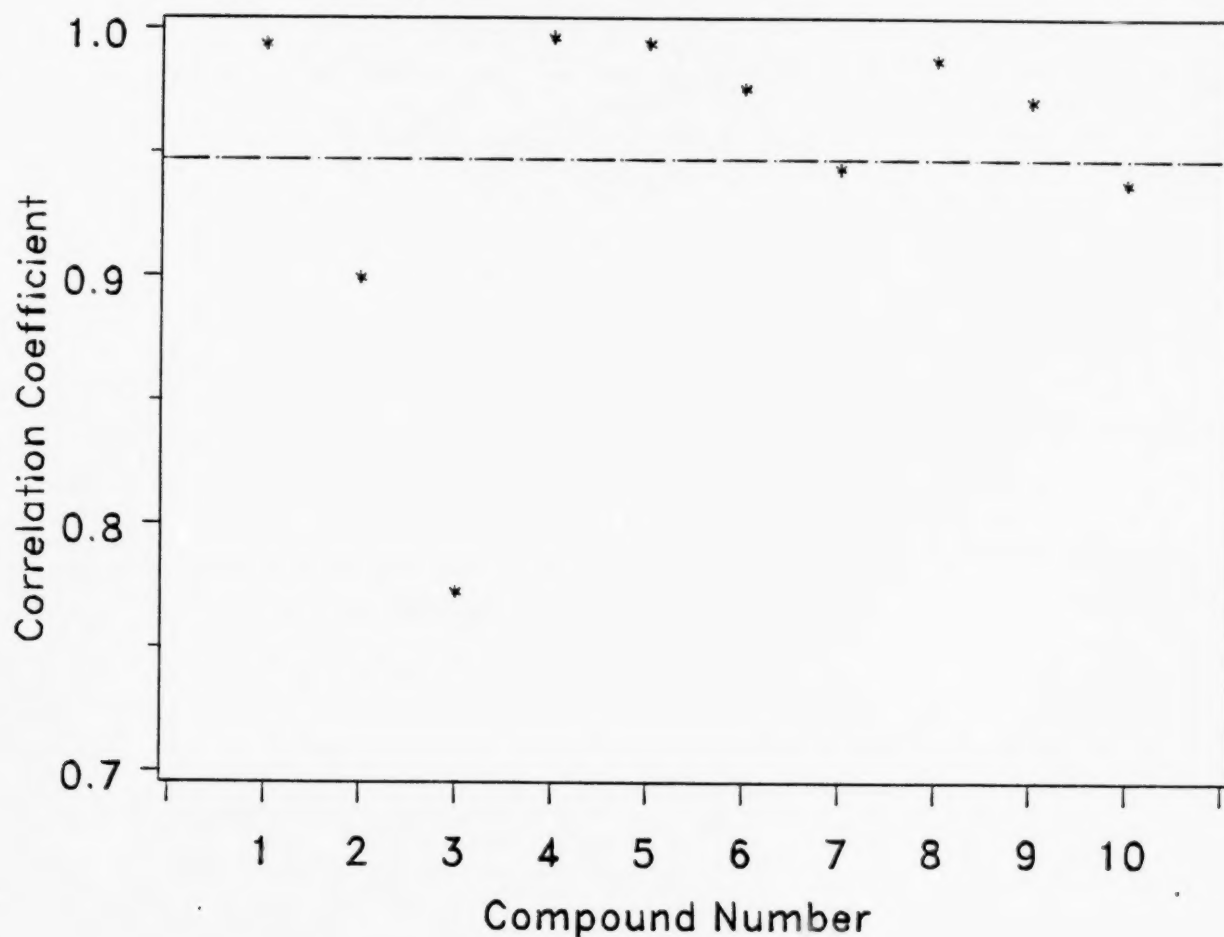


Data from table VA

Dashed line - mean over all values shown

FIGURE 8 CORRELATION

Tenax Low Rate Personal Sampling Device and Canister
Correlation of Tenax Mean and Canister Mean

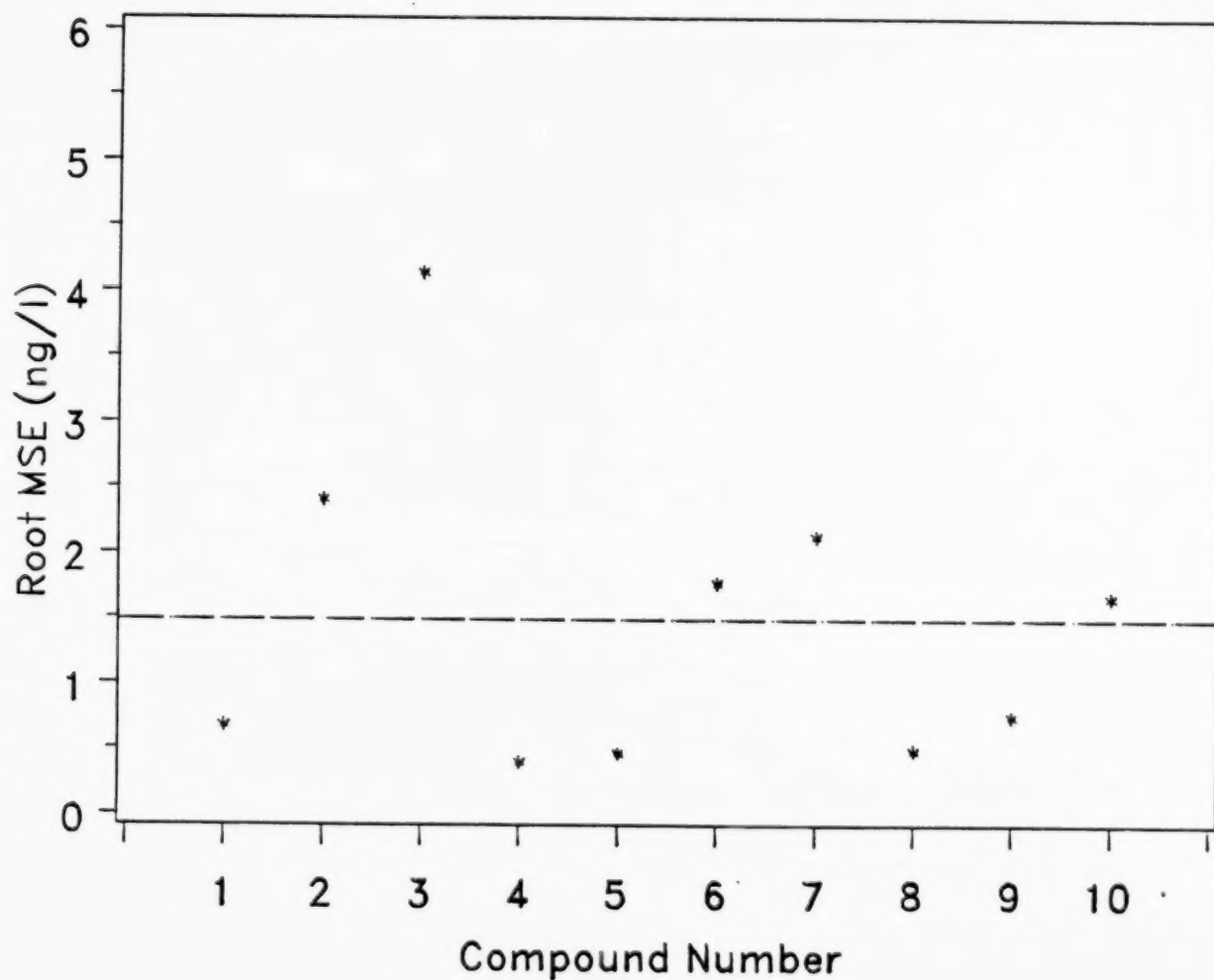


Data from table VA

Dashed line - mean over all values shown

FIGURE 9 SCATTER

Tenax Low Rate Personal Sampling Device and Canister
Linear Regression of Tenax Mean vs Canister Mean

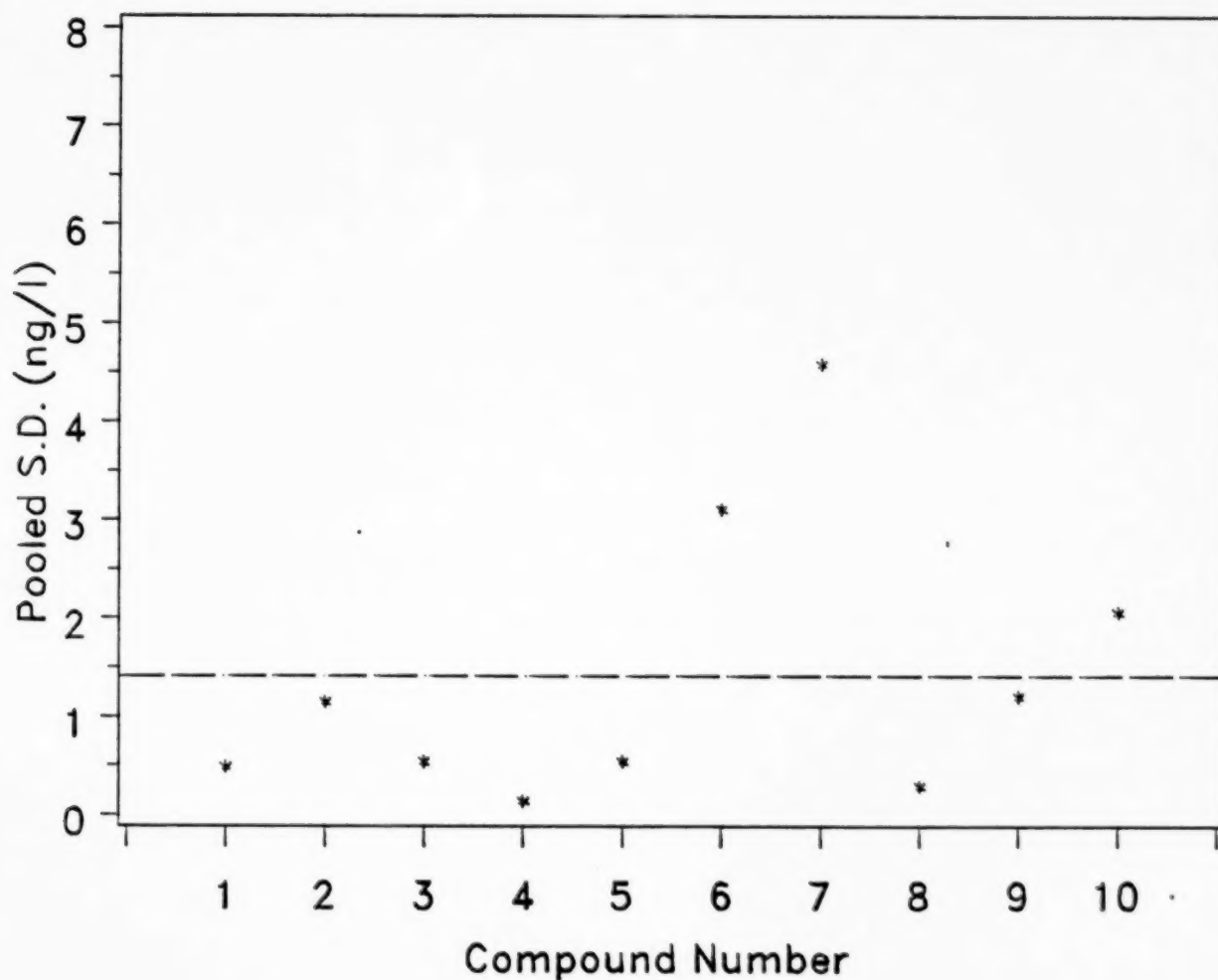


Data from table VB

Dashed line — mean over all values shown

FIGURE 10 PRECISION

Tenax High Rate Personal Sampling Device
Standard Deviation From Pooling Variance



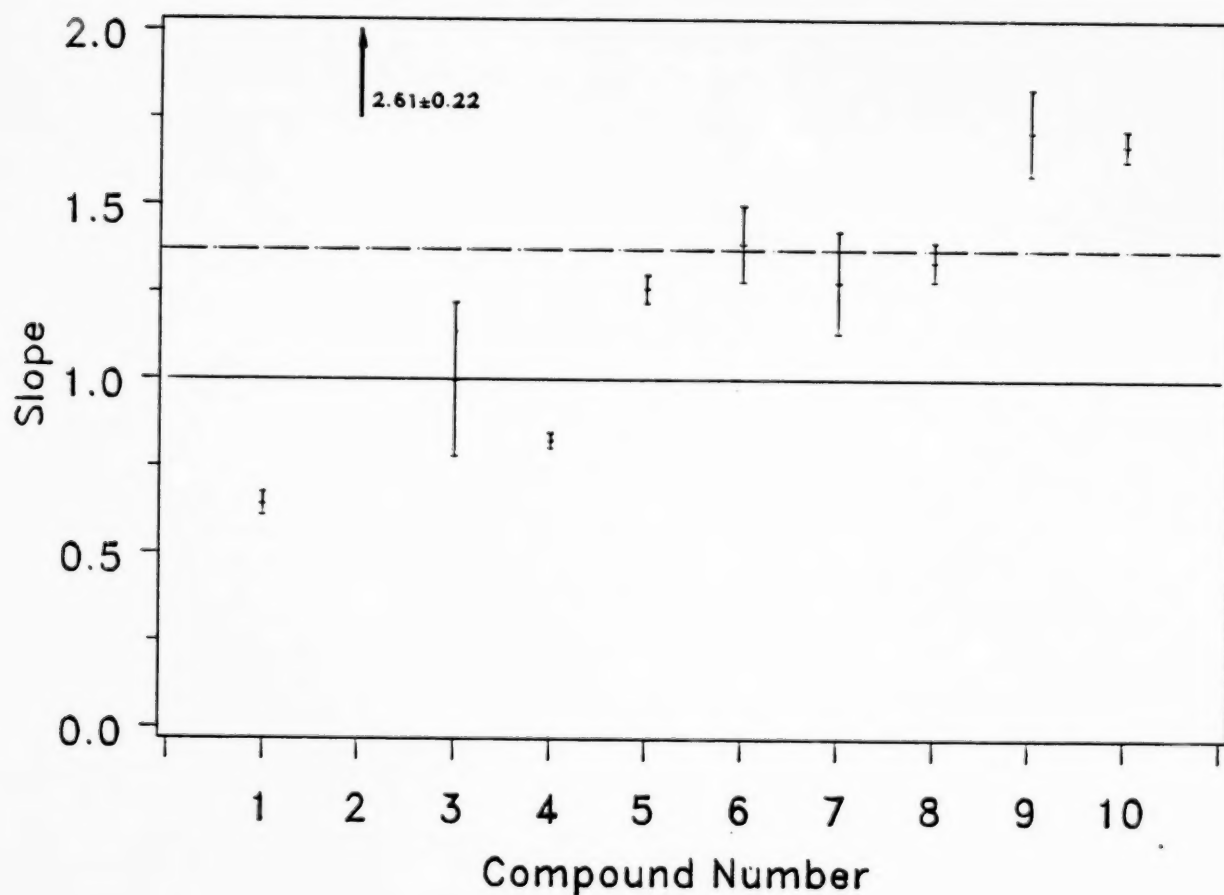
Data from table VIB

Dashed line — mean over all values shown

FIGURE 11 AGREEMENT

Tenax High Rate Personal Sampling Device and Canister
Slope Plus and Minus One Standard Error from the
Linear Regression of Tenax Mean vs Canister Mean

(same as Figure 26 in main text)

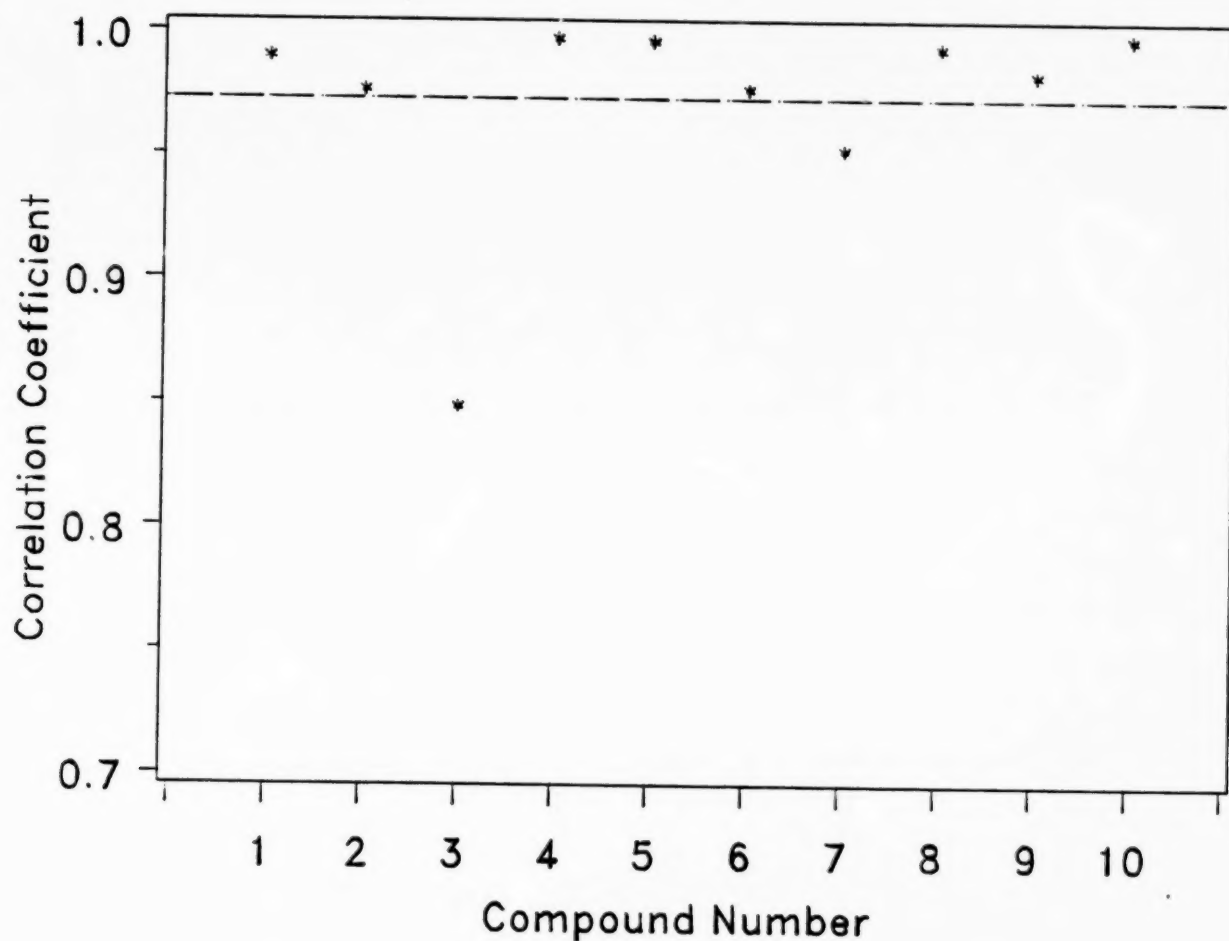


Data from table VIA

Dashed line - mean over all values shown

FIGURE 12 CORRELATION

Tenax High Rate Personal Sampling Device and Canister
Correlation of Tenax Mean and Canister Mean

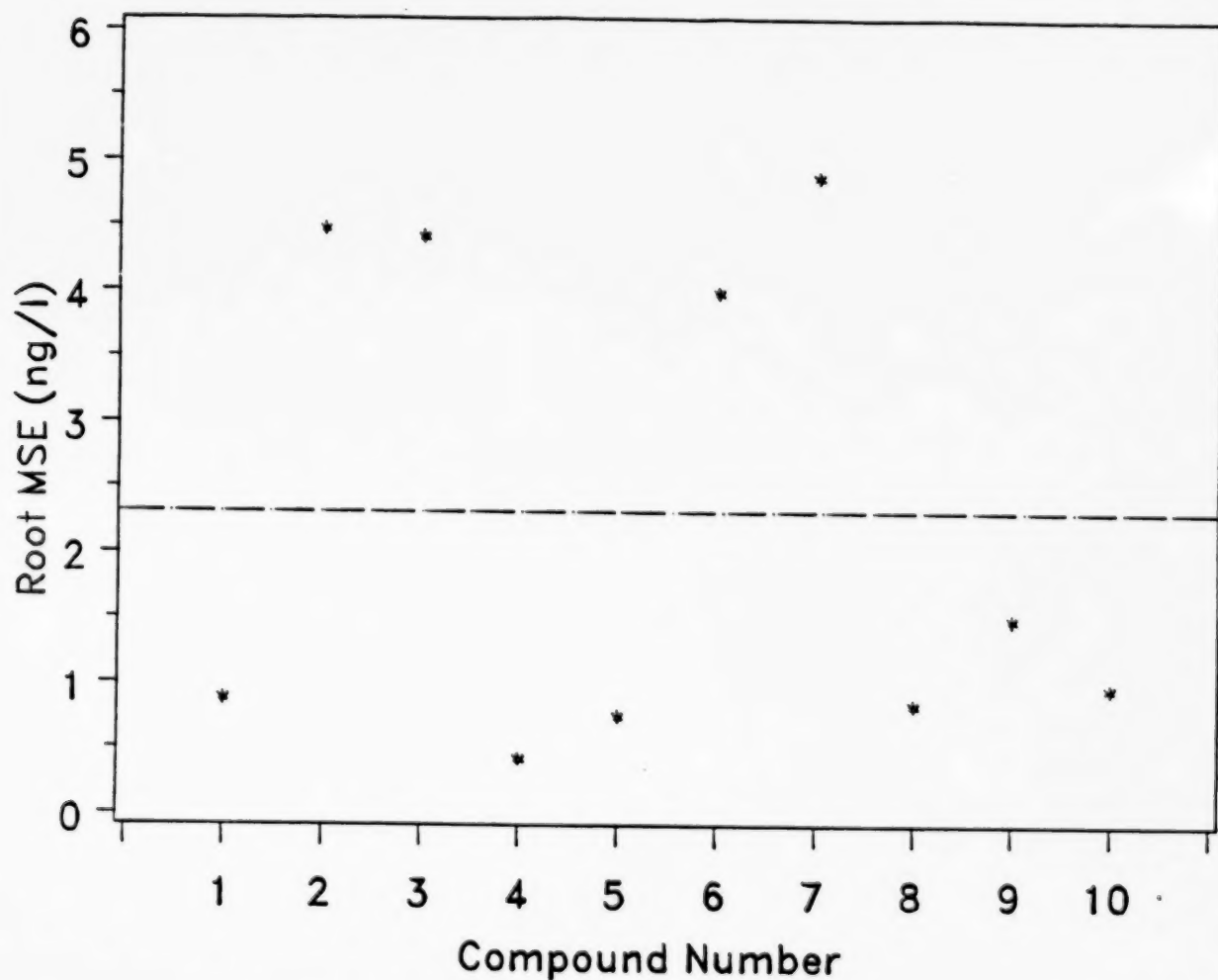


Data from table VIA

Dashed line — mean over all values shown

FIGURE 13 SCATTER

Tenax High Rate Personal Sampling Device and Canister
Linear Regression of Tenax Mean vs Canister Mean



Data from table VIB

Dashed line - mean over all values shown